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URETEROINTESTINAL IMPLANTATION

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THE clinical results secured in recent years by transplantation of the ureters into the rectosigmoid have established this operation as a sound procedure in our armamentarium of urologic surgery. Since the advent of intravenous urography, careful examination of the urinary tract may be made in patients prior to and after operations, so that the physiologic status of the kidney pelves, calices, and ureters may be ascertained following transplantation. We know that, provided the technical details of the operation are followed, the dynamics of the kidneys and the ureters as well as the functional activities of the kidney remain fairly normal.

AGE OF PATIENT

Operation in Children.—It has been stated that if surgical relief is not afforded, 50 per cent of the children with exstrophy of the bladder die before the age of ten years and 66 per cent before the age of twenty years. A critical review of the causative factors associated with death in these individuals reveals that marked impairment of renal function and renal infection are the etiologic factors in the majority of cases. Furthermore, those individuals who do attain adult life frequently have pyelectasis, ureterectasis, renal infection, and impaired renal function as demonstrated by intravenous urographic studies. Although urologists have been cognizant of these complications, it has been advised that operation be postponed until the child is three or more years of age. In the past two years at the Cleveland Clinic, our attitude regarding this conception has changed. Must operation be postponed until the child

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has attained the age of three years? We have seen children with exstrophy of the bladder who had not reached this age but in whom impairment of renal function and renal infection with hydronephrosis and dilatation of the ureters were already demonstrable.

Through eons of time, the infant has been subjected to the trauma of passing through the birth canal, and it tolerates surgical procedures quite well. In other fields of surgery, delay is not countenanced; plastic operations for cleft palate, the Rammstedt operation for pyloric obstruction, operative interventions for intussusception, and other surgical procedures are performed with no hesitation. Therefore, the determining factor in deciding on operative intervention is the competency of the rectal sphincter in the individual case. This can be ascertained in the infant by gentle insertion of the gloved finger into the rectum. The rectal tone can be noted and the gripping action of the sphincter elicited when the child cries. It is also true that during the early months of the child's life, the virulent organisms which are found in later years are not as abundant, and although peritonitis is now an unusual complication following transplantation of the ureters into the bowel, the risk of this complication is definitely lessened. The care these children require naturally creates a very close maternal and paternal affection which becomes greater as the child grows older. Therefore, in view of the possibility of a mortality, it is better to perform operation at an early age before this attachment has become too pronounced.

We now believe that the operation can be performed with safety any time after the age of three months. In our series of twenty-seven children with exstrophy of the bladder in whom transplantation of the ureters has been performed, six have been five months of age or less, nine less than five years of age (Fig. 1), and the remaining twelve were more than five years of age. In the younger infants, it has been of interest to note the slight clinical reactions that have accompanied the operative procedures and the technical difficulties have been much less than would be anticipated.

Operation in Adults.—When transplantation of the ureters is advised for carcinoma of the bladder, additional problems arise. Some individuals at the age of seventy years have withstood the strain and vicissitudes of life with less evidence of physical damage than others at the age of sixty years. Coexistent pathologic processes, such as hypertension, myocardial degeneration, or renal insufficiency, must be considered in determining the most suitable procedure to be recommended in these patients. Here again, individualization is essential to determine whether cystectomy can safely be advocated or whether a less radical procedure should be employed.

The condition of the kidneys and ureters is influenced by the position of the tumor in the bladder. If the growth encroaches on the ureteral

orifices, thereby producing obstruction with dilatation of the ureters, hydronephrosis, impaired renal function, and infection, the radical operation may not be justifiable, since the general condition of the patient would not be compatible with such a major surgical procedure; and the technical difficulties and, in some instances, the impossibility of transplanting the large dilated ureters would contraindicate such an operation even in younger individuals. On the other hand, if the tumor has

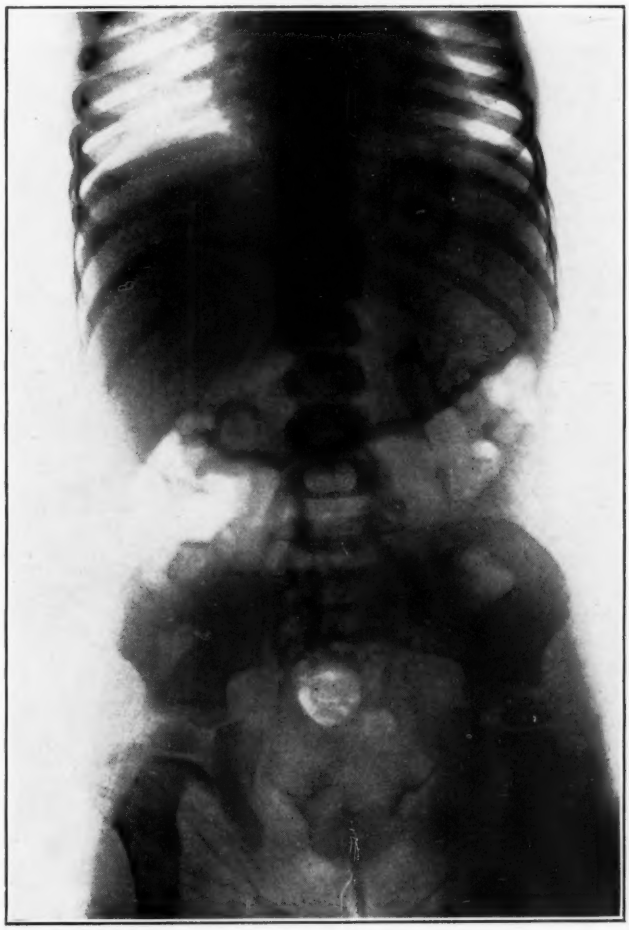

Fig. 1.—Male child, four years of age. Intravenous urogram made two days following bilateral simultaneous transplantation of ureters. Note normal pyeloureterogram with no stasis. Author's technique.

not produced such complications, the operation may be advised even though the patient be sixty or seventy years of age.

In our series of thirty-four cases of carcinoma of the bladder in which transplantation of the ureters into the sigmoid and cystectomy have been performed, one patient was seventy-seven years of age; nine were over sixty years of age; eight were between fifty and sixty years; and the remaining sixteen patients were under fifty years of age. Thus the

maximum age at which the operation should be performed is dependent entirely upon the general condition of the patient, the status of the kidneys and ureters, and the presence or absence of coexistent pathology.

PREOPERATIVE CARE

Although there have been numerous refinements in the operative technique, less attention has been directed to the pre- and postoperative management.

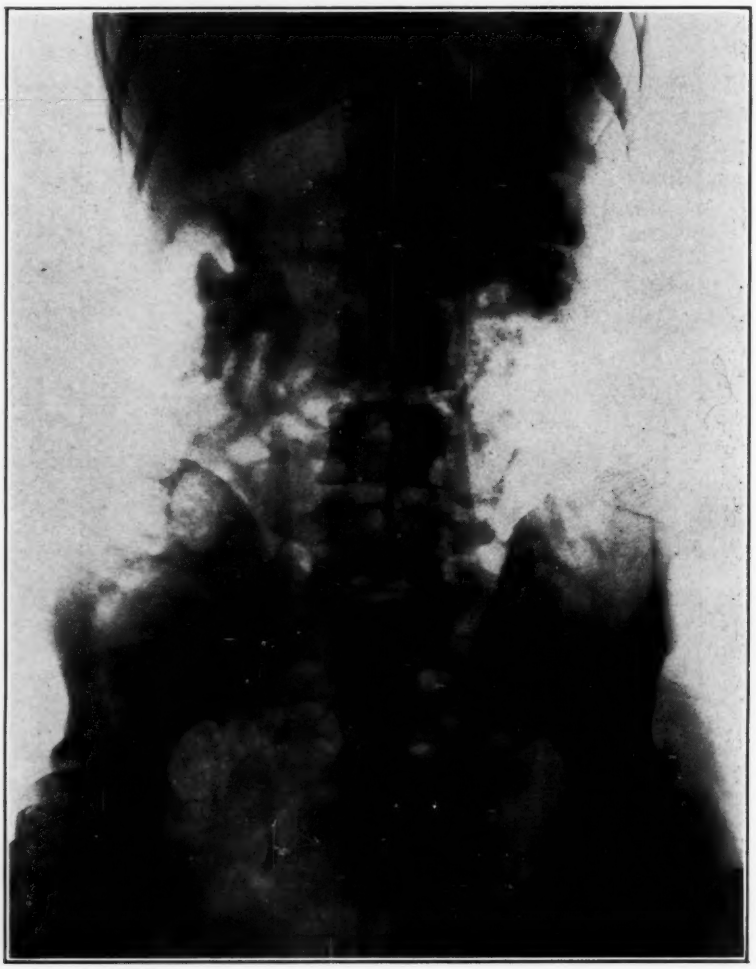

Fig. 2.—Girl, seventeen years of age. Preoperative intravenous urogram. Exstrophy of the bladder.

We are all aware of the necessity for an exacting preoperative routine in surgery of the large bowel and of the reduction in the mortality and morbidity that has followed its institution. Similarly, in transplantation of the ureters into the rectosigmoid, preparation of the bowel for its new function is essential and constitutes one of the most important steps in the entire procedure.

The preoperative preparation of the bowel which we employ is similar to that used by T. E. Jones in preparing his patients for operations upon the colon:

1. A liquid, nonresidue diet is supplemented by candy, glucose, and gelatin.

2. One thousand cubic centimeters of a 10 per cent solution of glucose is administered intravenously each day. The glucose is given with saline

Fig. 3.—Same patient as shown in Fig. 2, two months after bilateral simultaneous transplantation of ureters. Note less evidence of stasis, dilatation of the ureters, and hydronephrosis. Author's technique.

solution if the kidney function is not impaired, but if the function is decreased, distilled water is substituted for the saline solution.

3. Magnesium sulphate is administered orally each day. One ounce of magnesium sulphate is dissolved in eight ounces of water; and one ounce of this mixture is taken every half hour, starting at 7:00 A.M., but none is used on the day prior to operation.

4. The bowel is cleansed with an enema each day.

5. Provided there are no other complications, the number of days of preparation preoperatively depends upon the renal function and the cleanliness of the bowel. When all enemas return clear, the bowel is considered clean. The day before operation, an enema is given in the morning and at night.

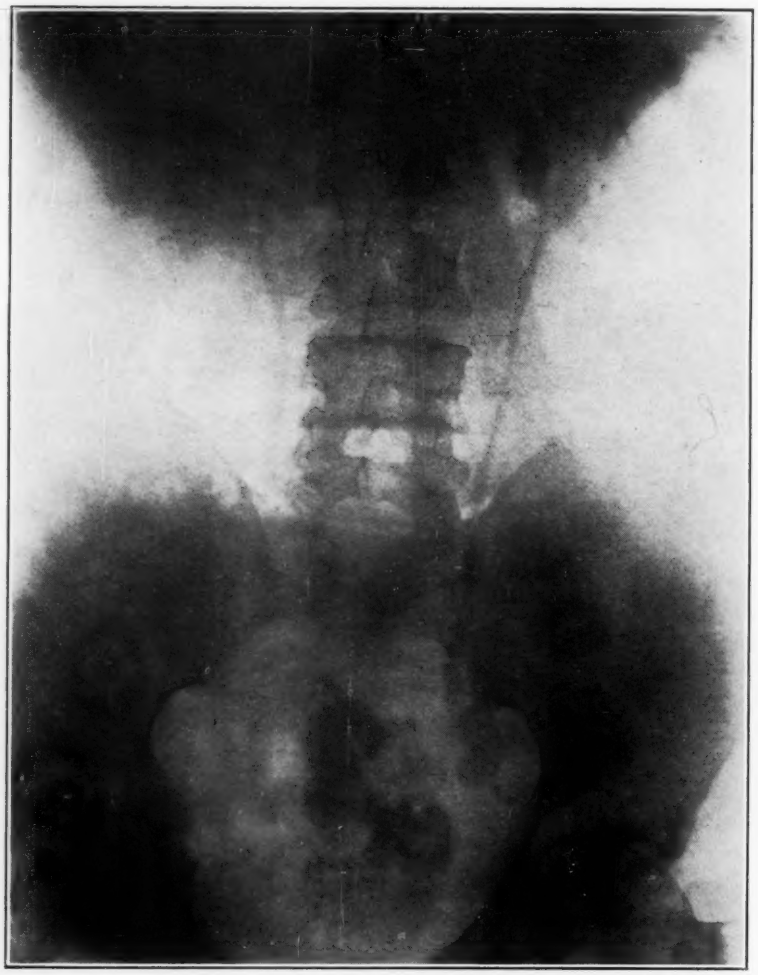

Fig. 4.—Doctor, fifty-six years of age. Intravenous urogram two years after transplantation of ureters into the rectosigmoid for carcinoma of the bladder. Coffey I technique.

6. Two drams of paregoric are prescribed at intervals of two hours for three doses, usually from 4:00 to 8:00 P.M. the night before operation.

7. Blood transfusions are used when indicated by the general condition of the patient and the blood picture.

8. Urinary antiseptics are administered orally or intravenously as indicated.

9. Miscellaneous supportive measures are employed as necessary.

This routine is utilized for adult patients and obviously must be modified for children with exstrophy of the bladder.

ANESTHESIA

We prefer to use ether as an anesthetic for children as it promotes complete relaxation, permitting excellent exposure which is a prime

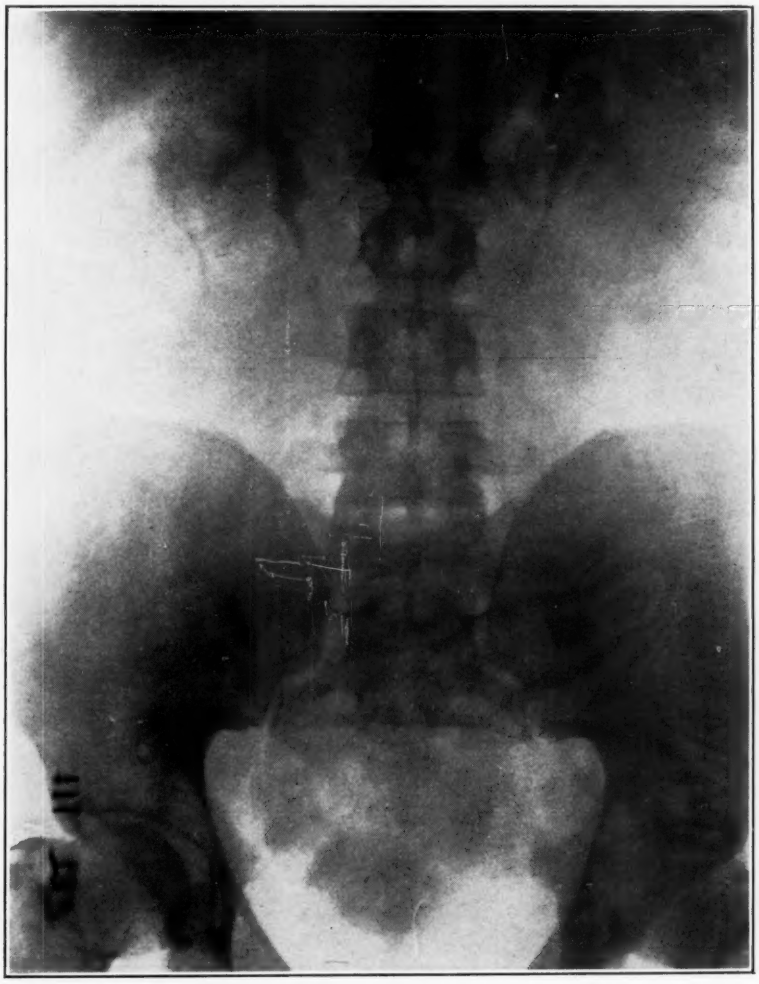

Fig. 5.—Man, twenty-two years of age. Intravenous urogram nine years after transplantation of ureters for exstrophy of the bladder. Coffey I technique.

requisite in this operation. For the adult patients, providing there are no complications, we prefer spinal anesthesia for both the cystectomy and transplantation of the ureters. During the operation, a 10 per cent solution of glucose in saline is administered intravenously through a vein in either the foot or the hand. This is of value as a supportive measure and assists in maintaining the blood pressure at a satisfactory level during the operation.

OPERATION

The choice of operation is influenced by several factors, one of the most important of which is the familiarity of the surgeon with the various techniques. Certainly, the procedure to be employed is that which is attended by the lowest mortality and morbidity in the hands of each surgeon. It is my belief that no one surgical procedure is applicable to

Fig. 6.—Woman, twenty-five years of age. Intravenous urogram made twelve years after transplantation of ureters for exstrophy of the bladder. Modified Coffey I technique.

all cases. In other fields of surgery, the procedure to be utilized is influenced by the pathology present in the individual case. In thyroid surgery, graded operations may be necessary; while in patients with pyloric obstruction due to an ulcer, a partial gastric resection, anterior gastroenterostomy, or posterior gastroenterostomy may be advisable. Experience, however, has led us to formulate certain principles which are applicable under various circumstances.

The problem arises as to whether unilateral transplantation of the ureters should be performed or whether both ureters should be transplanted simultaneously. In our hands this depends upon the operative technique employed, the renal function, the presence or absence of renal infection, whether or not dilatation of the ureters is present, and the general condition of the patient. At the present time we use either of two techniques:

(1) The Coffey I technique—the oblique submucous plan without the use of tubes or catheters; (2) The transfixion suture technique described by us in 1933.

In patients in whom the Coffey I technique is employed, we believe that unilateral transplantation should be performed. The right ureter is transplanted into the sigmoid first, and ten or twelve days later the left ureter is transplanted into the rectosigmoid if there are no contraindications. After the transplanted ureters are functioning well, as evidenced by intravenous urographic studies, and when the patient's condition is satisfactory, the bladder is removed. As a general rule, the clinical reaction following transplantation of the first ureter is more pronounced than that following transplantation of the second ureter. A moderate elevation of the temperature and pulse rate occurs for a short period of time, but this does not persist and in a few days returns to normal.

As shown by the experimental investigations of Vermooten and ourselves, when the Coffey I technique is employed, the portion of the ureter protruding into the lumen of the bowel becomes markedly edematous and frequently is the site of an acute inflammatory reaction for a few days. This edema and inflammatory process is conducive to the production of stasis and in some instances produces a temporary obstruction to the passage of urine into the bowel. It can also be observed that edema involves the ureter incorporated in the bowel wall, as well as the muscular layers of the sigmoid at the site of transplantation. Stasis resulting from these factors can be demonstrated in our clinical cases by means of intravenous urographic studies secured the first few days after transplantation of the ureters into the bowel. As the inflammatory process and edema subside, there is a disappearance of evidence of stasis as revealed by intravenous urography. We, therefore, do not believe it advisable to perform bilateral simultaneous transplantation of the ureters if the Coffey I technique is employed. Various modifications of the operation have also been suggested, such as bilateral transplantation of the ureters by the Coffey I technique and cystectomy at one operation, or transplantation of one ureter (Coffey I) followed by transplantation of the opposite ureter by the same technique and cystectomy ten or twelve days later. These procedures are accompanied by a higher mortality and at the present time are hardly justifiable.

It is rarely necessary to place catheters or tubes in the ureters. In a few cases in which the lower end of the ureter has been dilated, we have used a catheter at the time of operation to serve as a splint. If one kidney has been removed previously or if transplantation of the ureter from a solitary kidney is being performed, the use of a catheter at the time of transplantation may be advisable to eliminate the possibility of temporary obstruction of the ureter.

In cases in which the transfixion suture technique suggested by us is employed, both ureters are transplanted simultaneously. This may be accomplished with safety as the continuity of the ureters is not interrupted until a new channel is established and functioning and the urine is coursing through the new communication into the bowel. Thus the urine continues to pass into the bladder for a period of forty-eight to fifty hours until the new channel forms. After this has been established, approximately two-thirds of the urine passes into the bowel and one-third into the bladder until the ureters are divided and ligated at the time of cystectomy, thereby diverting all the urine into the bowel.

We have found, however, that this technique is not always applicable. Occasionally in children with exstrophy of the bladder, the ureters do not occupy the normal position, and if both ureters were to be transplanted simultaneously, there would be too much tension on the line of anastomosis. Likewise, in adults in whom considerable fat is found to be present in the mesocolon, the technique is not as satisfactory as the Coffey I.

In our experimental animals, providing the technique is correctly employed, there is no more evidence of hydronephrosis or hydroureter with the transfixion technique than if the Coffey I principle is utilized. Likewise, when the rectal tube principle has been employed, the suture always has produced a fistula both in our experimental animals and in our clinical cases. We have secured postoperative urograms in our clinical patients over a period of three years following operation by the transfixion suture technique, and they show that the anastomosis is functioning well with no evidence of closure of the channel; the kidneys and ureters compare favorably with those seen following the Coffey I operation.

POSTOPERATIVE CARE

1. The patients are maintained in the supine position for 8 hours if spinal anesthesia is employed; then they are maintained in Fowler's position.

2. The blood pressure is taken every 15 minutes until it returns to normal.

3. No fluids by mouth are allowed for at least 48 hours and then small amounts of water are taken orally for 12 hours. During the fol-

lowing hours, clear fluids are started with one ounce hourly, and this amount is gradually increased. A low residue diet is then given for a period of 5 to 7 days.

4. The fluid intake is maintained at 3,000 c.c. daily. During the first two days, 2,000 c.c. of a 10 per cent solution of glucose is administered intravenously and 1,000 c.c. of saline solution infusion daily. After this, fluids are given intravenously as indicated by a study of the blood chemistry and the amount of fluid by mouth.

5. Narcotics are prescribed as necessary.

6. A rectal tube is inserted at the time of operation. This may be changed but is replaced and left in the rectum for a period of 8 or 10 days. The rectal tube is irrigated gently at intervals of two hours to insure patency. If the transfixion suture technique is employed, gentle traction is made on the rectal tube at the end of 24, 36, and 48 hours until the tube containing the sutures is expelled. A plain rectal tube is then reinserted for a period of 5 to 7 days.

7. Blood chemistry studies (urea and creatinine) are made daily until they remain at normal levels.

8. Ten cubic centimeters of salihexin is combined with the intravenous glucose as a urinary antiseptic for the first 3 or 4 days following operation.

9. General supportive measures are prescribed as indicated.

NOTE: In children the postoperative routine is modified.

SUMMARY AND CONCLUSIONS

1. An exacting pre- and postoperative routine is essential in patients upon whom cystectomy and transplantation of the ureters is contemplated.

2. The end-results secured by this operation have standardized it as a sound surgical procedure.

3. Peritonitis is rarely a complication, and in our hands, acute infection of the kidney with multiple abscesses in the renal parenchyma has been the chief postoperative complication which resulted in a mortality.

4. Transplantation of the ureters into the bowel is the procedure of choice for the treatment of exstrophy of the bladder, and by its use many patients with carcinoma of the bladder in whom conservative procedures are not indicated may be salvaged.

5. The operation can safely be performed in infants and should be done before complications develop in the kidneys and ureters.

IMPLANTATION OF THE URETERS INTO THE COLON

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URETEROINTESTINAL implantation has become established as of greatest value in the treatment of exstrophy of the bladder and of certain congenital and acquired disturbances of the vesicourethral mechanism in which urinary incontinence has not responded to conservative plastic procedures. In this group are cases of (1) complete epispadias with urinary incontinence, (2) traumatic injury of the bladder and the urethra, resulting in such conditions as extensive vesicovaginal fistula, and (3) inflammatory lesions of the bladder, so decreasing its capacity that constant dysuria is present, as in some cases of renal tuberculosis and certain cases of chronic interstitial cystitis. The operation also is used as a preliminary to total cystectomy for very extensive, otherwise inoperable, carcinomas of the bladder.

The risk of the operation is dependent on the general condition of the patient, on the degree of infection of the kidneys, and on the degree of obstruction of the ureters, with particular reference to their size; the greater the size of the ureter, the greater is the risk of ureterointestinal implantation.

The participants in this symposium have been asked to discuss certain points, some of which will now be taken up briefly.

SPECIAL PREPARATION OF THE PATIENT

Patients who are thought to be candidates for ureterointestinal implantation are subjected, in addition to general physical examination, to studies of renal function. With reference to this last, estimation of the concentration of the blood urea is particularly valuable. Intravenous urograms are of the greatest assistance in determining the function of the kidneys; they also outline the pelves and the ureters. Routine studies of this type are made prior to and subsequent to operation in all cases. If exstrophy of the bladder exists, ureteral catheterization can be performed easily; this permits study of the constituents of the urine from each kidney, to see whether infection is present. The competence of the anal sphincter is determined (1) from the history and (2) by palpation. With the finger in the anus, it is possible to determine whether the sphincter muscles are normal in size and whether they can maintain adequate closure. It is particularly important to know whether liquid stools can be retained.

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Patients are sent into the hospital for four days of preparation. This consists of administration of laxatives, colonic irrigation, giving of a nonresidue diet, and lately, intraperitoneal vaccination with a mixed vaccine containing equal parts of streptococci and organisms of the colon group that have been isolated from patients dying of peritonitis. Approximately 3,000 c.c. of fluid a day is given.

ANESTHESIA

For children, general anesthesia of the gas-oxygen-ether type is used as a routine. For adults, whenever the condition of the patient permits, spinal anesthesia with procaine is employed. The quantity of procaine depends on the weight of the patient, but more than 150 mg. never is used.

METHOD OF IMPLANTATION

For exstrophy of the bladder, the original submucosal method of Coffey and Mayo, in which one ureter is transplanted at a time without the use of tubes or catheters, has been a routine in the Mayo Clinic since 1912. In that year, C. H. Mayo first successfully applied to the ureter Coffey's method of submucosal transplantation of the common bile duct.[1, 3, 5] Since the method has been described on several previous occasions,[6-8, 12-14] space will not be taken here to describe it at length. The ureter is isolated through a transperitoneal incision; the end of the ureter is passed between the mucous membrane and the more superficial layers of the sigmoid for a distance of approximately 3.5 to 4 cm. and then is carried into the lumen of the colon. When only one kidney is present, I have placed a ureteral catheter in the ureter to prevent stasis at the anastomosis in the early days after operation. This is particularly valuable if the ureter has been dilated.

In all cases of exstrophy, one ureter is transplanted at a time. The interval between transplantations of the two ureters is at least two weeks; it may be longer if after two weeks the patient has not sufficiently recovered in general health to permit what seems to be safe transplantation of the second ureter. It is particularly important to postpone implantation of the second ureter if evidence of pyelonephritis exists following the first ureteral implantation. In a case of exstrophy of the bladder, if the patient is a male, cystectomy and plastic operation on the urethra are reserved for a third stage.

The reason for performing operation in stages in cases of exstrophy of the bladder is the fact that our experience at the clinic has proved that the risk of operation is far less when one ureter is transplanted at a time than when a simultaneous bilateral transplantation is carried out. This is particularly true if the patients are young children. Moreover, the stay in hospital of our patients who were operated on in stages was approximately the same as that reported to be required for patients

who were subjected to simultaneous bilateral transplantation. Interestingly enough in this connection, our series includes many cases in which, in addition to transplantation of the ureters and removal of the bladder, plastic operation was performed on the penis, either at the time the bladder was removed or shortly afterward. Again, comparing the postoperative progress in our cases with that in cases in which simultaneous bilateral transplantation was performed elsewhere,[3, 13] it was noted that the reactions from the operation were extremely more severe and more prolonged, as indicated by mortality or by fever and increase in pulse rate, when the ureters were transplanted simultaneously. It has been the experience at the clinic that when one ureter has been transplanted at a time postoperative reactions usually were slight. The fever and increase in pulse rate last for a few days subsequent to transplantation of the first ureter only, and following transplantation of the second ureter very little reaction occurs. If the patient is in good condition, removal of an exstrophied bladder and plastic operation on the penis both are regarded as operations without appreciable risk. The decision whether to transplant one ureter at a time or both together in cases in which exstrophy of the bladder is not present, I think, depends largely on the condition of the patient and on the lesion for which the operation is performed. Generally speaking, the good results which have followed transplantation of one ureter at a time, using the original method of Coffey, in the treatment of exstrophy, have influenced the surgeons of the Mayo Clinic to adopt such a procedure as a routine in other cases, with the possible exception of cases of extensive carcinoma of the bladder.

In carcinoma of the bladder the problem presented is entirely different from that presented by exstrophy of the bladder or by other benign lesions of the urinary apparatus. If total cystectomy is contemplated, the lesion is not only an extensive one but one which involves the base of the bladder and trigon and which has produced various degrees of ureteral obstruction, associated with which renal infection has developed. The patients usually are debilitated, not only as a result of their malignancy, but also as a result of the associated infection and the disturbance of renal function. In such cases any operative procedure, even cystostomy, frequently carries a considerable operative risk. In these cases I think the decision whether to transplant one ureter at a time or both simultaneously, preliminary to cystectomy, should be made in the light of the circumstances present in the individual case. This is particularly true if dilatation of the ureters is present.

AGE OF PATIENTS SELECTED FOR THE OPERATION

It has been the custom at the Mayo Clinic to postpone ureteral transplantation in cases of exstrophy of the bladder until the patient has gained control of the rectal sphincteric mechanism. Usually this control is not attained until the patient is three years of age. It was the

early experience of C. H. Mayo that if the ureters were transplanted to the rectum before control over expulsion of the rectal content was acquired, such control was delayed as a result of the liquid contents of the rectum. If the condition present is other than exstrophy of the bladder, the decision to operate or not is based less on the age of the patient than on his general condition, particularly as this is affected by the lesion for which ureteral transplantation is contemplated.

FACTORS INFLUENCING THE RISK OF OPERATION

In cases of exstrophy of the bladder, as has been stated previously, the risk of the operation is increased if a ureter is dilated. If a catheter is not used in anastomosis, and if stasis occurs at the site of the ureterointestinal anastomosis, one should not hesitate to perform temporary nephrostomy. I have had to do this on only two occasions in a series of operations in which approximately seventy-five ureters have been transplanted. In one of these cases, the patient was a child who had a solitary kidney.

A very important part of the technique of transperitoneal ureteral implantation appears to be the turning of the colon in such a fashion, after the transplantation, that the line of suture is directed posteriorly and lies in contact with the posterior parietal peritoneum, so that the small intestine cannot become adherent to the site of the implantation. Should postoperative pyelonephritis develop, treatment is directed toward this: Fluids are administered intravenously, transfusion of blood is given, and on a few occasions I have given methenamine or small doses of mercurochrome intravenously; recently mandelic acid has been given by mouth in these cases with good results.

The third stage required in some cases has been mentioned. When ureteral transplantation has been performed for exstrophy of the bladder, cystectomy has been reserved until the patient has completely recovered from the transplantation of the ureters. Usually cystectomy has been performed about the tenth day after transplantation of the second ureter. At the same time, plastic procedures on the penis, if the patient is a male, can be carried out. When ureteral transplantation has been done for complete epispadias with urinary incontinence, or for large vesicovaginal fistula, or for contracted bladder as a result of interstitial cystitis, cystectomy has not been performed.

COMMENT AND SUMMARY

It is our opinion at the clinic that in operating on children with exstrophy of the bladder, or complete epispadias and urinary incontinence, the ureters are best transplanted into the rectosigmoid at different stages and that accurate submucosal transplantation, as originally described by Coffey and C. H. Mayo, can be performed with a low mor-

tality and with good results. In this method the open end of the ureter is carried into the lumen of the sigmoid colon. A large amount of clinical evidence would seem to justify the conviction that the open end of the ureter can be placed accurately in the lumen of the bowel and that evident infection is unlikely to develop at the site of the anastomosis providing the colon has been cleaned by the method of preliminary preparation described. This being true, the transfixion suture necrosis technique, which has been described as an aseptic method of anastomosis (which, of course, it is not), appears to have no particular advantage. Furthermore, the possibility is real that the suture might not cause the desired necrosis and that the anastomosis subsequently would not establish itself, thus leading to hydronephrosis and destruction of the kidney. Such results have been reported. On experimental animals the transfixion necrosis suture technique was followed, immediately or remotely, by hydronephrosis and considerable destruction of renal parenchyma in practically every case.

Cystectomy should be a part of every operation for exstrophy of the bladder. At the same time, if the patient is a male, plastic operations on the penis can be performed. The necessity of removing an exstrophied bladder is evident from the fact that the operation eliminates the chronic irritation of the exposed bladder which is prone to eventuate in malignant degeneration. Restoration of the penis to a reasonably normal contour has a psychologic as well as a physiologic effect.

In the past twenty-four years, at the Mayo Clinic, the ureters have been transplanted in separate stages, without the use of tubes or catheters, in treatment of more than a hundred cases of exstrophy of the bladder. When the mortality statistics in this, more than a hundred cases, is compared with those of bilateral, simultaneous ureteral transplantation, with the use of catheters, it is evident that the risk of bilateral simultaneous ureteral transplantation is far in excess of that of transplantation in stages, without the use of catheters. Furthermore, in operating on children the advantages of simultaneous bilateral transplantations are not apparent, since the hospital mortality in these cases and in cases in which the operation is performed in two stages is practically identical. Adding further weight to the argument in favor of ureteral transplantation in stages is the fact that more severe and more prolonged reactions follow bilateral simultaneous transplantation than follow transplantation in stages.

REFERENCES

1. Coffey, R. C.: Physiologic Implantation of the Severed Ureter or Common Bile Duct Into the Intestine, J. A. M. A. **56**: 397-403, 1911.
2. Coffey, R. C.: A Technic for Simultaneous Implantation of the Right and Left Ureters Into the Pelvic Colon Which Does Not Obstruct Ureters or Disturb Kidney Function, Northwest Med. **24**: 211-215, 1925.

3. Coffey, R. C.: Transplantation of the Ureters Into the Large Intestine. Submucous Implantation Method: Personal Studies and Experiences, Brit. J. Urol. **3**: 353-428, 1931.
4. Cutts, R. E.: Time of Appearance of Urine in the Rectum After Transplantation of the Ureters Into Sigmoid in Children: Relation to Postoperative Course and Ultimate Results, J. Urol. **30**: 129-132, 1933.
5. Mayo, C. H.: Exstrophy of the Bladder and Its Treatment, J. A. M. A. **69**: 2078-2081, 1917.
6. Mayo, C. H.: The Formation of a Cloaca in the Treatment of Exstrophy of the Bladder, S. Clin. North America **1**: 1257-1266, 1921.
7. Mayo, C. H., and Hendricks, W. A.: Exstrophy of the Bladder, Surg., Gynec. & Obst. **43**: 129-134, 1926.
8. Mayo, C. H., and Walters, Waltman: Transplantation of Ureters Into Rectum. End-Results in Thirty-Five Cases of Exstrophy of the Bladder, J. A. M. A. **82**: 624-626, 1924.
9. Nitch, C. A. R.: Transplantation of the Ureters Into the Large Intestine, Proc. Roy. Soc. Med., Sec. Urol. **25**: 1413-1430, 1932.
10. Randall, L. M., and Hardwick, R. S.: Pregnancy and Parturition Following Bilateral Ureteral Transplantation for Congenital Exstrophy of the Bladder, Surg., Gynec. & Obst. **58**: 1018-1020, 1934.
11. Walker-Taylor, P. N.: Experimental Transplantation of the Ureters Into the Intestine, Australian & New Zealand J. Surg. **1**: 158-191, 1931.
12. Walters, Waltman: Transplantation der Ureteren in das Recto-Sigmoid und Exstirpation der Blase zur Behandlung der Ectopia vesicae. Bericht über 76 Fälle, Arch. f. klin. Chir. **167**: 589-600, 1931.
13. Walters, Waltman: Transplantation of Ureters to Rectosigmoid and Cystectomy for Exstrophy of Bladder: Report of Seventy-Six Cases, Am. J. Surg. **15**: 15-22, 1932.
14. Walters, Waltman: Transplantation of Ureters to the Sigmoid-Colon for Exstrophy of Bladder and Other Ureteral Abnormalities With Urinary Incontinence (Unilateral Versus Simultaneous Bilateral Transplantation), Proc. Staff Meet., Mayo Clin. **7**: 470-472, 1932.

ASEPTIC URETEROSIGMOIDOSTOMY

A New Method Providing Definite Asepsis in Respect of Both Fecal and Urinous Soiling

A Preliminary Report

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THE purposes of this preliminary report are to put on record the first definitely aseptic method of ureterointestinal anastomosis to be described, to point out its simplicity, and to invite experimental and clinical use of it to the end of early determination of its usefulness.

The new method described here is definitely aseptic in respect of both fecal and urinous soiling. It involves use of a newly devised snare or guillotine instrument (Fig. 1) within the bowel lumen but imposes no technical elaborations or difficulties. The ligated end of ureter, pushing a small invaginated tent of bowel submucosa before it, is inserted into the snare (Fig. 3). The two structures are held in the grip of the snare while the ureter is imbedded in the bowel wall by suture and the abdomen closed, all of which is accomplished without even a suture needle penetrating the lumen of either bowel or ureter. Later, with supply of a cutting current to the instrument, the snare amputates within the bowel lumen the ligated ureter end and the invaginated tent of bowel submucosa covering it, thus establishing the ureterointestinal communication. The new instrument has been called a ureteral transplanter.*

Design and Construction of the Ureteral Transplanter

The instrument, Fig. 1, consists of a hard rubber end piece containing the snare or guillotine, a flexible shaft, and an operating handle. The movable element of the snare or guillotine is in the form of a wire loop electrode contained in a slot within the hard rubber. By means of a wire stem extending back through the flexible shaft to the operating handle, the loop electrode may be moved across the snare hole. When not supplied with current, the loop acts as a snare. Later, when supplied with a cutting current, it acts as a guillotine to amputate the tissue in its grip—the ligated end of ureter and its covering tent of invaginated submucosa—thus establishing communication.

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*The instrument was made by Frederick C. Wappler, E. E., of American Cystoscope Makers, Incorporated. With his customary interest and devotion to the problems of the urologist and with characteristic insight, the required instrument was promptly produced. Acknowledgment is made of Mr. Wappler's important assistance and contribution to the problem.

MANAGEMENT AND TECHNIQUE OF OPERATION

The usual preparatory measures, including particularly thorough cleansing of the rectosigmoid by catharsis and repeated enemas, are employed.

Spinal anesthesia is most desirable. The complete relaxation of the abdominal muscles and the tonic contraction of the intestinal smooth muscle induced by it greatly facilitate the whole procedure. Thickening of the muscular layer of the bowel incident to its tonic contraction facilitates accurate incision of it, imbedding the ureter in the incision and placing the imbedding sutures. Likewise tonic thickening and absence of flaccidness of the submucosa gives added safety against inadvertent puncture and contamination by the anchoring sutures or tearing by other manipulations.

The ureteral transplanter, well lubricated, is inserted through the anus and is advanced up into the bowel a distance of 25 cm. or less if

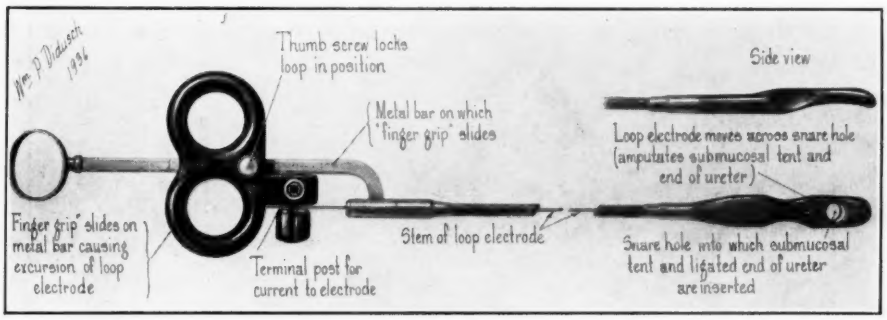
Thumb screw locks loop in position
Metal bar on which "finger grip" slides
Finger grip" slides on metal bar causing excursion of loop electrode
Terminal post for current to electrode
Stem of loop electrode
Side view
Loop electrode moves across snare hole (amputates submucosal tent and end of ureter)
Snare hole into which submucosal tent and ligated end of ureter are inserted

Fig. 1.—The ureteral transplanter. The instrument consists of a hard rubber distal end piece comprising a snare or guillotine, a flexible shaft containing the snare stem, and an operating handle at the proximal end. A tungsten wire loop, contained in a slot within the hard rubber distal end piece, is movable across the snare hole by operation of the finger grip of the operating handle. A thumb screw on the finger grip locks the loop in any desired position. Through a terminal on the operating handle, a high frequency cutting current may be supplied to the loop.

resistance to passage is encountered. Between the separated thighs of the patient a sterile field is prepared for manipulation of the shaft of the instrument and the operating handle. With the patient in Trendelenburg position, the abdomen is opened by low median incision. The lower part of the peritoneal cavity and the pelvis are walled off with moist gauze packs with exposure of the posterior abdominal wall and rectosigmoid.

The end piece of the transplanter in the bowel lumen is readily palpable through the bowel wall. The operating handle and flexible shaft of the instrument lying in a sterile field may be manipulated by the operator with one hand while the end piece within the bowel is manipulated with the other hand. By such bimanual manipulation it will be possible to bring the snare opening into appropriate position under the submucosa for transplantation of the right ureter.

The site for union on the bowel is carefully selected (Fig. 2). This selection should provide the best possible anatomic relations for function of the anastomosis that are compatible with the technique of its establishment. The site for division of the ureter appropriate to the site for transplant in the bowel is determined. Incision of the posterior parietal peritoneum for exposure of the ureter should be well planned and ac-

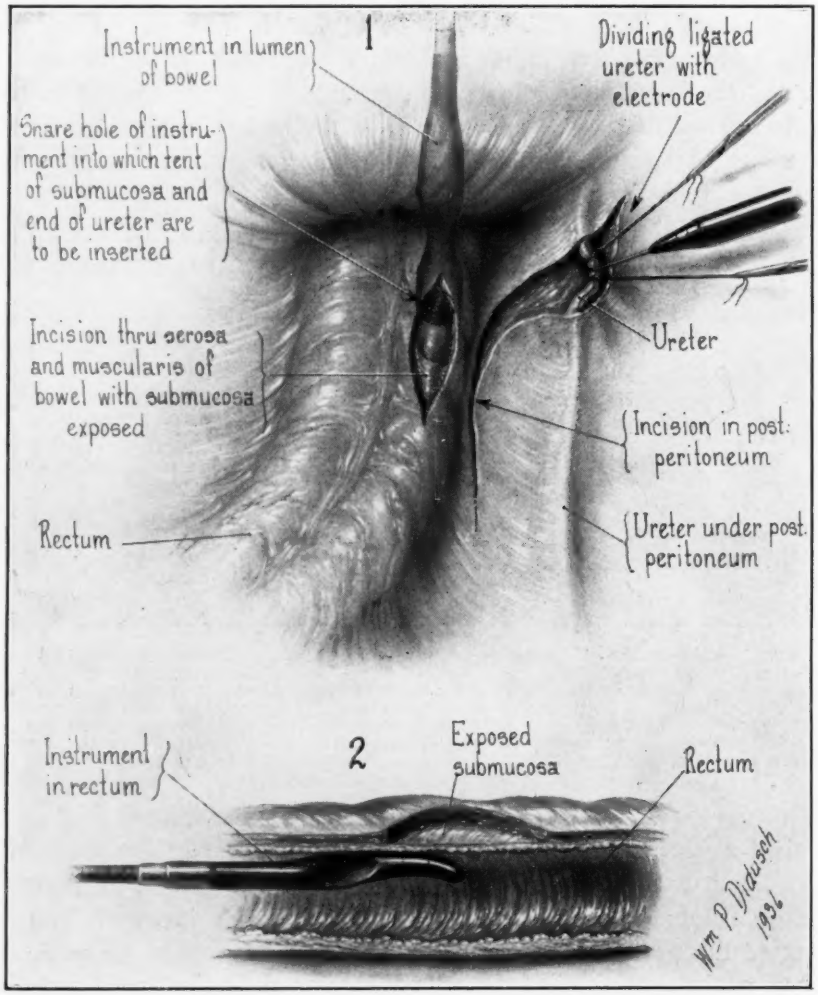
1
Instrument in lumen of bowel
Snare hole of instrument into which tent of submucosa and end of ureter are to be inserted
Incision thru serosa and muscularis of bowel with submucosa exposed
Rectum
Dividing ligated ureter with electrode
Ureter
Incision in post. peritoneum
Ureter under post. peritoneum
2
Instrument in rectum
Exposed submucosa
Rectum
Wm. P. Didusch 1936

Fig. 2.—Aseptic ureterosigmoidostomy. *1.* The ureteral transplanter, introduced through the anus, is shown in shadowed outline within the lumen of the rectosigmoid in position for operation. The snare is in the open position. The operating handle at the proximal end of the instrument (not shown) lies in a sterile field between separated thighs of the patient where it may be manipulated by the operator. The posterior parietal peritoneum has been incised. The incision begins above the level of the site for transplant, extends downward parallel and close to the bowel, and turns lateralward to cross the ureter slightly below the level for transplant on the bowel. The ureter has been doubly ligated and is being divided between the ligatures with a cautery. The serosa and muscularis of the bowel have been incised longitudinally, exposing the submucosa, injury of which is carefully avoided. *2.* A perspective section of the bowel shows the ureteral transplanter in the bowel lumen, its snare hole (indicated by dotted lines) appropriately placed in relation to the lower end of the incision in the muscularis.

curately placed. The incision begins close to the mesocolon several centimeters above the site on the bowel selected for union. The incision is carried downward parallel to and close to the mesocolon and turns lateralward to cross the ureter at the site determined for division. Here

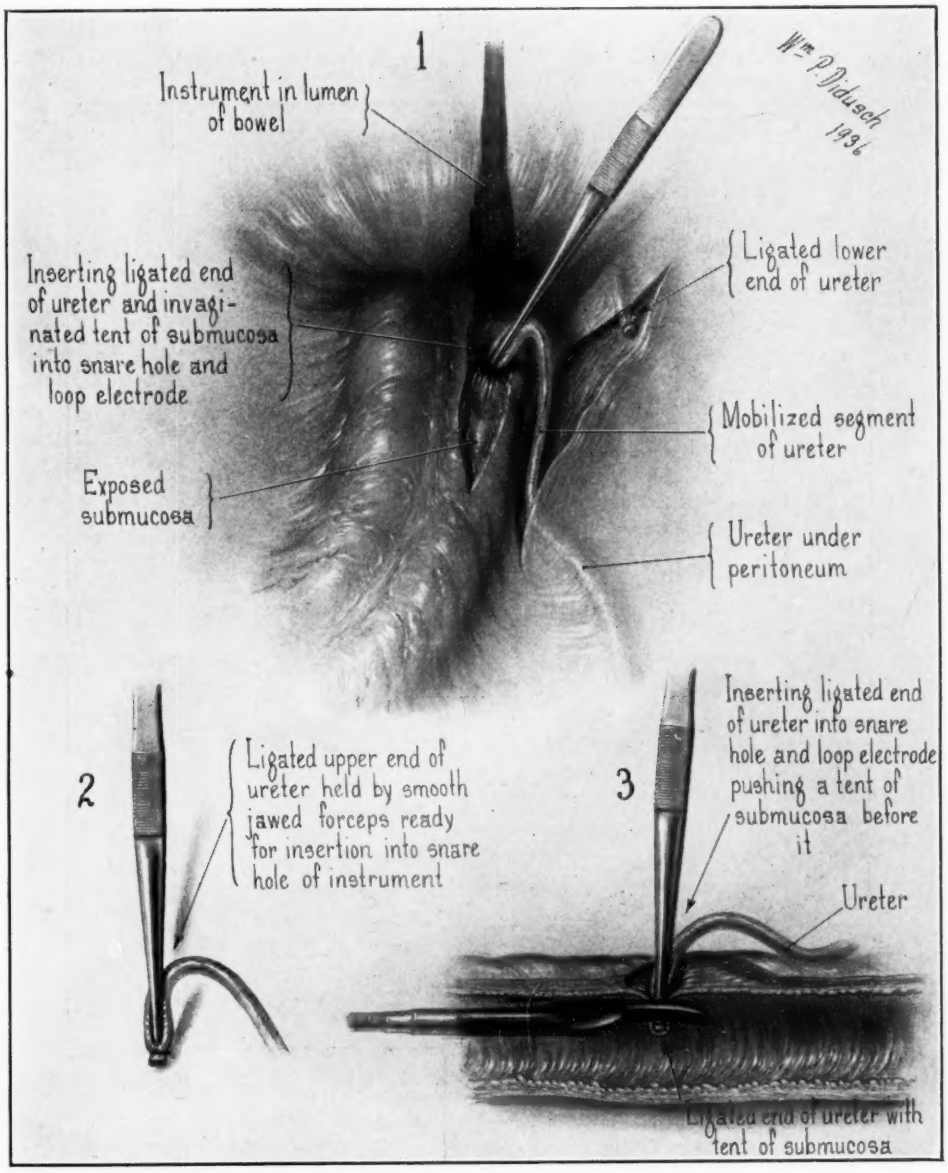
1
Instrument in lumen of bowel
Wm P. Didusch 1936
Inserting ligated end of ureter and invaginated tent of submucosa into snare hole and loop electrode
Ligated lower end of ureter
Mobilized segment of ureter
Exposed submucosa
Ureter under peritoneum
2
Ligated upper end of ureter held by smooth jawed forceps ready for insertion into snare hole of instrument
3
Inserting ligated end of ureter into snare hole and loop electrode pushing a tent of submucosa before it
Ureter
Ligated end of ureter with tent of submucosa

Fig. 3.—Aseptic ureterosigmoidostomy. *1.* The ureteral transplanter is clearly palpable through the bowel wall and so grasped is held in position at the site of operation. The ureter has been freed and brought medialward from under the peritoneum. The ligated cauterized, and sterile upper end of ureter is inserted into the snare hole of the ureteral transplanter, invaginating and pushing before it a protecting tent of the tough and elastic submucosa. *2.* The ureter is held in smooth jawed tissue forceps slightly above the ligated end which is to be gripped by the snare above the ligature. *3.* A perspective section of the bowel shows detailed relationships of the ligated ureter end, invaginated tent of submucosa covering it, and both structures inserted into snare opening preparatory to tightening the snare.

the ureter is freed and doubly ligated. The ligatures are placed 5 mm. apart and are tightly tied. With the immediate field protected by gauze, the ureter is divided between the ligatures with the electrocautery (either galvanic or diathermic current) and each ligated end is sterilized by application of additional heat. The protecting gauze and instruments used in this step are discarded. The ureter is freed for an appropriate distance upward and is brought medialward from its position under the

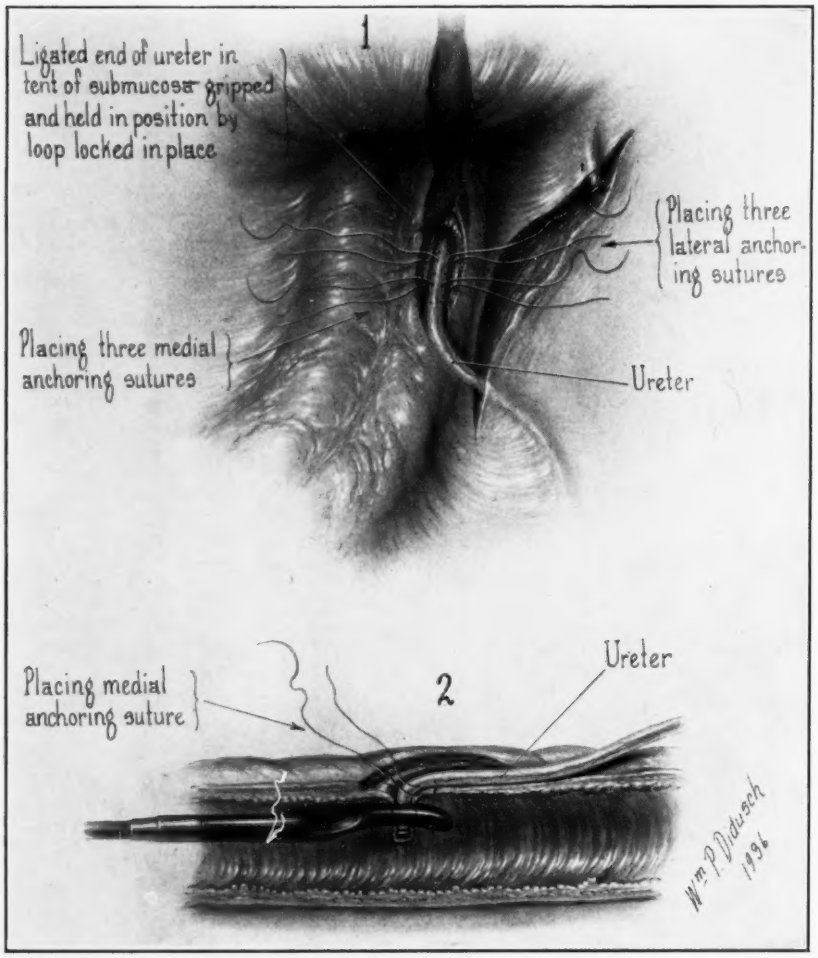
1
Ligated end of ureter in tent of submucosa gripped and held in position by loop locked in place
Placing three lateral anchoring sutures
Placing three medial anchoring sutures
Ureter
2
Placing medial anchoring suture
Ureter
Wm. P. Didusch 1936

Fig. 4.—Aseptic ureterosigmoidostomy. The ligated end of ureter covered by an invaginated tent of submucosa is held in the grip of the ureteral transplanter snare. The thumbscrew at the proximal end of the instrument (not shown) has been tightened, locking the snare loop in position. Three interrupted sutures on each side of the ureter anchor the ureter to the submucosa. The lowest suture on each side has been tied and its ends cut. (For details of placing these sutures see Fig. 5.)

peritoneum lateral to the incision. The serosa and muscularis of bowel are incised longitudinally close to the mesocolon from the site for union upward a distance of 5 cm. The incision extends completely through the muscle but carefully avoids injury of the underlying tough and elastic submucosa. The end piece of the ureteral transplanter is now brought into position within the bowel lumen so that the snare opening lies

against the submucosa in the lower angle of the incision in the muscularis. With the end piece of the transplanter felt through the bowel wall and held in this position, the ureter, seized in a smooth-jawed tissue forceps (*2* in Fig. 3) just behind its ligated end, is inserted into the snare opening pushing the submucosa before it. An invaginated tent of submucosa is thus protruded into the snare opening (*3* in Fig. 3). The tent of submucosa and ligated end of ureter contained in it are gripped in the snare hole by movement of the loop toward the closed position. A set screw locks the loop in this position transfixing the sub-

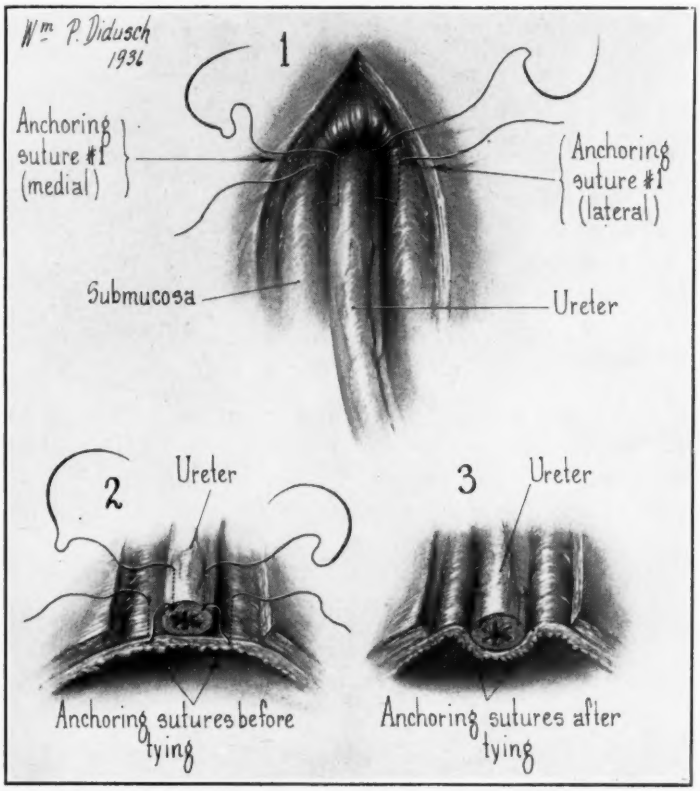

Fig. 5.—Aseptic ureterosigmoidostomy. Details of placing the anchoring sutures according to the method of Hinman. The suture material is 000 chronic catgut and is affixed to a small curved atraumatic needle. *1.* The bite of the suture in the ureter wall is taken in longitudinal direction to avoid constriction of the ureteral lumen. The bite in the submucosa is taken parallel to the bite in the ureter. The lower suture on each side is shown in place. Three such sutures on each side of the ureter (as shown in Fig. 4) give secure anchoring and provide against slipping incident to peristaltic movements of ureter and bowel. *2.* The bites of apposing sutures in the submucosa are taken some little distance away from the ureter so that when tied (*3*) there is sufficient lax submucosa between the sutures to encircle the ureter apposed to it without constriction.

mucosal tent and its contained ureter in position for completion of the anastomosis. The anchoring sutures are then placed (Fig. 4) according to the details of technique suggested by Hinman.[1] It would seem important that the end of the ureter and the opening to be made in the submucosa be fixed in correct and permanent relationship to each other and that during repair they should not be subject to position change

incident to contraction of the muscularis. For this purpose, three anchoring sutures on each side of the ureter unite it with the submucosa. In order not to constrict the ureter, the bite of these sutures is placed longitudinally in the wall of the ureter in strict accordance with Hinman's recommendation (Fig. 5). The edges of the muscularis incision are brought together over the ureter by interrupted sutures of fine catgut (*1* in Fig. 6) and the serosa is approximated over this line of

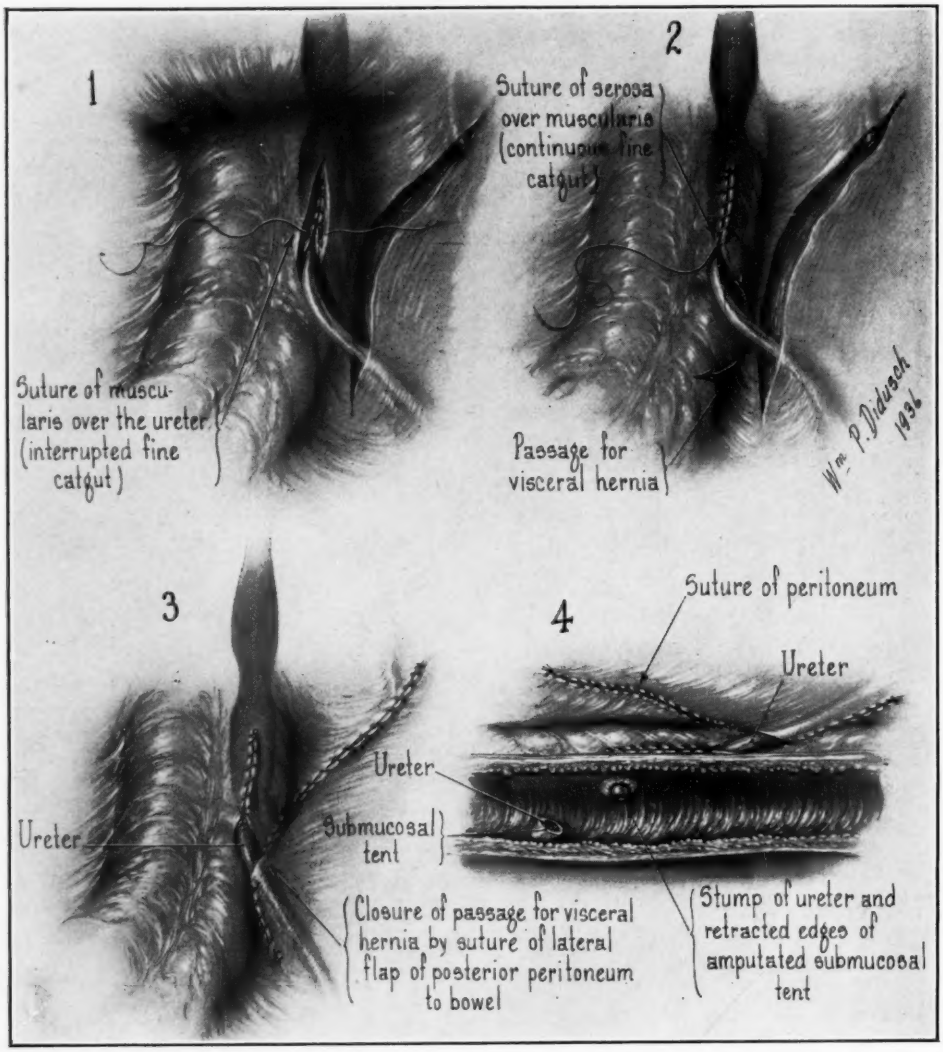
1
Suture of muscularis over the ureter (interrupted fine catgut)
2
Suture of serosa over muscularis (continuous fine catgut)
Passage for visceral hernia
Wm. P. Didusch 1936
3
Ureter
Ureter
Submucosal tent
Closure of passage for visceral hernia by suture of lateral flap of posterior peritoneum to bowel
4
Suture of peritoneum
Ureter
Stump of ureter and retracted edges of amputated submucosal tent

Fig. 6.—Aseptic ureterosigmoidostomy. *1*. The muscularis is approximated over the ureter by interrupted sutures of 0 plain catgut. *2*. The serosa is approximated over the muscularis by a continuous suture of No. 1 plain catgut. As indicated by an arrow, a space between bowel, ureter, and posterior abdominal wall is formed through which a loop of small bowel or omentum might pass as a visceral hernia. *3*. The lateral edge of the incision in the peritoneum, in the upper part of its extent, is drawn medialward over the ureter and is sutured to the surface of the parietal peritoneum and serosa of the bowel, thus closing the passageway between bowel, ureter, and posterior abdominal wall. *4*. After an interval of time to permit sealing off of tissue spaces at the site of transplant, connection is made for supply of a high frequency cutting current to the snare loop. As the current is turned on, the snare loop is moved to the closed position, amputating the ligated end of ureter and submucosal tent covering it, thus establishing communication of ureter with bowel.

sutures with a continuous suture of 0 plain catgut (*2* in Fig. 6). Where the ureter approaches the bowel, the lateral edge of the peritoneal incision for exposure of the ureter is sutured to the bowel (*3* in Fig. 6), thus closing the triangular opening between ureter, bowel, and posterior abdominal wall through which a visceral hernia might pass.

Although the communication between ureter and bowel lumina has not yet been established by amputation of the submucosal tent and ligated end of ureter, all suturing for the anastomosis has been completed, and the tissue spaces at the site of union have been closed without ever having been exposed to either the opened ureter or opened bowel. During the whole procedure no instrument or suture has penetrated the lumen of either intestine or ureter. After an interval of time following operation, the loop electrode is supplied with a high frequency cutting current, and by completing its movement across the snare hole to the closed position it amputates the invaginated tent of submucosa and ligated end of ureter, thus completing the anastomosis (*4* in Fig. 6).

REPORT OF CASE

The instrument and method have been employed in one case reported in summary as follows:

CASE REPORT.—Ancker Hospital, No. A 450 096. Female, aged sixty-two years, extensive carcinoma of urethra with invasion of vesical neck and trigone. Complete retention of urine. Diminished pthalein excretion, nitrogen retention. Excretory urography showed normal pelves and ureters.

The urethra was dilated with sounds. Constant drainage with an indwelling catheter improved the renal function and general condition. Irradiation with radium element gave no favorable effect.

Bilateral transplantation of the ureters with a view to total cystectomy was determined upon.

December 3, 1935, the right ureter was transplanted by the method described. The procedure was executed with perfect facility. The submucosal tent and ureter end were amputated four hours later. Urine came from the bowel on the third day. General condition was excellent on the eleventh day. Temperature elevation and signs of bronchopneumonia were evident on the twelfth day. The patient died of bronchopneumonia on the fifteenth day.

Postmortem examination showed complete healing and union at the site of transplant. There was a pea-sized purulent accumulation between the ureter and the infolded serosa at the upper end of the suture line but no peritoneal exudate or infiltration and no dilatation of the ureter or kidney pelvis.

SUMMARY AND CONCLUSIONS

1. A new method for ureterosigmoidostomy providing definite asepsis in respect of both fecal and urinous soiling and an instrument for its performance are described and illustrated.
2. One case in which the operation was performed is reported.

REFERENCE

1. Hinman, Frank: A Simple Seven Suture Method of Bilateral Ureterointestinal Implantation, Surg., Gynec. & Obst. **60**: 802, 1935.

RHABDOMYOSARCOMA OF THE KIDNEY: CASE REPORT WITH AUTOPSY FINDINGS

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INTRODUCTION

SINCE Wilm's[7] lucid monograph on the embryonal mixed renal tumors of infancy, there has been accumulating a vast amount of material concerning these neoplasms. It is unnecessary to discuss here the etiology, symptomatology, and treatment of these tumors, since these have already been adequately reviewed recently by McCurdy,[3] Sinkoe and others,[6] Geschickter and Widenhorn,[2] and Mixter.[5] In these reviews, there are also excellent pathologic discussions.

This report concerns a rhabdomyosarcoma of the kidney which at the time of removal showed no evidence of metastases. Six months later the child died; and at autopsy, the entire vena cava from the level of the renal veins was filled with tumor which passed into the right heart. It was impossible to find any channel in the inferior vena cava for the return flow of blood. Only one similar case of a Wilm's tumor extending into the right heart is reported in the literature by Merkel.[4] He believes, however, that there may have been four such cases previous to his report, one of which is identical with his, but that the others are of uncertain histologic make-up and show no extension from the inferior vena cava into the right heart.

CASE REPORT

S. M. H., No. 112683, S. S., a white female infant, aged two and one-half years, was admitted to the Rochester Municipal Hospital on March 5, 1936, on the pediatric service.

Chief complaint: Abdominal pain, large abdomen, fever, and bloody urine.

Present illness: Three months before the patient entered the hospital, her mother noticed that the child did not look well and was fretful, but attributed this to teething. Thirteen days before admission, the patient complained of generalized abdominal pain. Two days later she became actively nauseated. The mother gave her an enema and at that time noticed that the abdomen was larger than formerly, and upon feeling it noticed it was unusually hard. Two days before admission the patient contracted a cold which was accompanied by a slight cough. The day of admission, while voiding, the mother noticed two small blood clots in her urine.

Past history: Spontaneous delivery. Normal birth weight. Pertussis at three months of age without sequelae. Family history: Noncontributory.

Physical Examination.—Temperature 40 degrees C.; respirations, 36; pulse, 128; blood pressure, 85/40. The patient appeared acutely ill. Skin dehydrated. Glands—

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anterior, posterior cervicals, axillary, and inguinal glands were shotty. Head—slightly prominent frontal bosses. Ears and eyes were normal. Nose—mucous membranes markedly injected with a slight amount of mucopurulent discharge. Mouth—tonsils moderately enlarged; pharynx mildly injected. Chest—slight costal flare and a definite Harrison's groove. The costosternal junctions were prominent. Lungs—negative. Heart—a blowing systolic murmur over the entire precordium; no enlargement to percussion.

Abdomen: On inspection the right side of the abdomen was more prominent than that of the left. On palpation there could be felt a hard, smooth, nontender, ballotable mass which filled the entire right side of the abdomen. It extended from the flank to the umbilicus, and from the costal margin to the iliac crest. Bowel

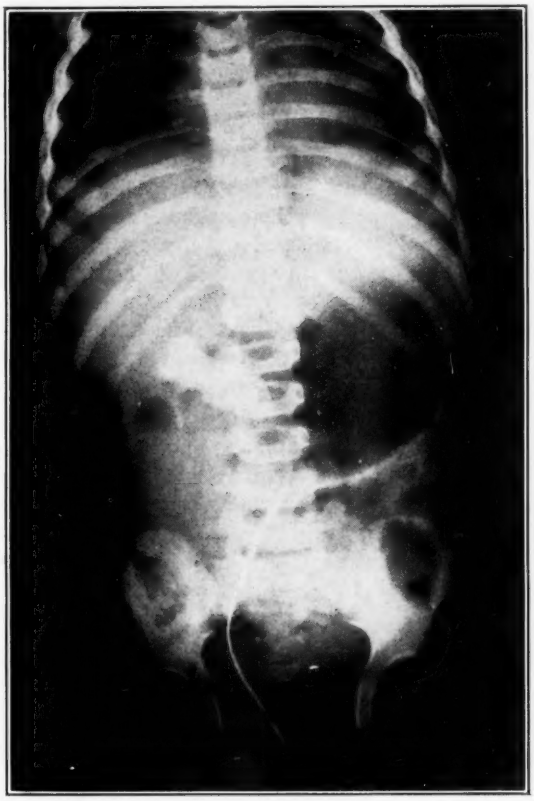

Fig. 1.—Pyelogram of right kidney showing filling defect.

could be felt over the mass. The left kidney, liver, and spleen could not be felt. Genitalia: Normal female infant. Reflexes: Physiologic.

Laboratory Findings.—Urine—cloudy. Acid. Albumin 0. Acetone 0. Guiac 2+. Microscopic examination showed an occasional white blood cell, 5 red blood cells per high power field, few epithelial cells, no casts. Stool—negative. Blood—Wassermann reaction was negative; red blood count, 3,550,000; white blood count, 14,800; hemoglobin, 11.3 gm. Differential studies revealed 69 per cent polymorphonuclears, 21 per cent small lymphocytes, 7 per cent mononuclears, 3 per cent eosinophiles, 0 per cent basophiles. Nonprotein nitrogen 25 mg. per 100 c.c.

Course in Hospital.—The patient was admitted to the pediatric service for a complete study. Roentgenogram of the abdomen confirmed the physical findings.

Phenolsulphonphthalein test for kidney function was unsatisfactory from a technical standpoint. An intravenous pyelogram was done which revealed a normally functioning left kidney with no demonstrable abnormalities. The right kidney was functioning to some extent as evidenced by the output of dye, but the pelvis was poorly filled. A retrograde stereopyelogram was done on the right kidney which revealed a moderately dilated pelvis. It was pushed upward and rotated anteriorly. The lower calyx was pushed posteriorly and the middle calyx elongated, curved, and thinned out. The deformity which was apparent in the pyelogram was interpreted as being due to a large mass involving the lower and middle portions of the kidney and causing the ureter to be pushed across the midline. The right kidney was uninfected. Roentgenographic studies for metastasis were negative. Diagnosis of a tumor of the right kidney was made and preoperative roentgen ray therapy instituted. The infant received 900 roentgen units to each of three fields. Five weeks after therapy was begun, examination showed the tumor to be more ballotable and slightly smaller in size. During her preoperative therapy, the patient was given three small blood transfusions. On April 11, 1936, a right nephrectomy was performed under ether anesthesia without difficulty, using the retroperitoneal approach.

Surgical Pathology.—Gross—specimen was that of a kidney and large, well-encapsulated tumor, the whole mass measuring 11 by 8 by 7 cm. It was very firm and had a smooth, glistening, reddish yellow surface. Posteriorly, a small portion of kidney parenchyma could be seen flattened out against the tumor. The pelvis was moderately dilated. The ureter appeared normal. There was a fairly sharp line of demarcation between the renal and tumor tissue. On section, at the upper pole, there could be seen compressed kidney tissue. The main portion of the mass was tumor which measured 9 by 7 by 7 cm. It appeared as a yellowish white, glistening mass of very dense tissue having no definite pattern. Scattered throughout the tumor were areas of hemorrhage.

Microscopic.—Sections taken from different portions of the tumor were similar in appearance. The tumor was made up of a dense connective tissue stroma through which ran parallel striated muscle fibers with elongated spindle shaped nuclei. The connective tissue in places appeared hyalinized. There were a few areas of hemorrhage. Scattered nests of cells were seen embedded in a somewhat rarefied connective tissue stroma. The nuclei of these cells varied in size and shape. Some were spindle shaped, while others appeared rounded. The cytoplasm was faintly acidophilic. Occasionally in the tumor one saw isolated remnants of tubules which in some instances were cystic. One section showed normal renal tissue which was separated partially from the invasion of the tumor by a zone of hyalinized tissue. Mitoses were rare. (Fig. 3.)

Postoperative Course.—The postoperative course was uneventful. She remained in the hospital for postoperative roentgen ray therapy which was begun seventeen days after operation and 42 days after termination of the preoperative course. In seventeen days she received 1,100 roentgen units to the right anterior abdomen, 1,000 roentgen units to the right lateral abdomen, and 1,200 roentgen units to the right posterior abdomen. She was discharged with instruction to return for check up.

Follow-Up.—June 24, 1936, the patient was seen in the clinic and looked well. The mother stated that the child was gaining weight and had a good appetite. Examination revealed the abdomen to be slightly increased in size. The liver was palpable for the first time. On June 30, 1936, the patient was readmitted to the hospital with complaint of swollen abdomen and fever. Examination showed an otitis media on the right and nasopharyngitis. Her respirations were increased. There were coarse râles throughout both lung fields. Roentgenogram of chest showed, for the first time, a few suspicious areas which were considered as representing metastases.

Check film one week later confirmed the first impression. She was given roentgen ray therapy, 1,200 roentgen units to the anterior chest and 1,200 roentgen units to

Fig. 2.—Upper pole of mass showing normal kidney.

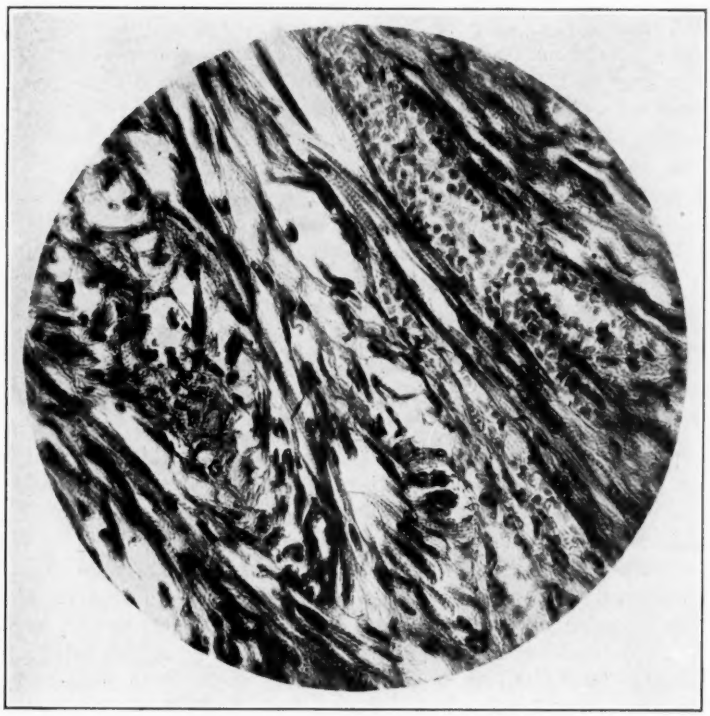

Fig. 3.—Photomicrograph showing the striated muscle fibers.

posterior chest. Roentgenogram of chest on July 20, 1936, showed no change. She was discharged July 17, 1936, to be followed in the clinic. On September 10, 1936,

she was readmitted with marked respiratory distress, cyanosis, and cough. Examination at this time revealed dullness at the right lung base and in the right axilla. A chest plate showed marked progression of metastasis. The child failed rapidly and died September 13, 1936.

Autopsy.—The *body* was that of a pale, undernourished, two-and-one-half-year-old female baby. The external skull was not remarkable, and there was no exudate or blood visible in the nose and ears. The pupils were dilated, and the mucous membranes of the mouth were pale. There was a well-healed scar over the right flank at the site of previous nephrectomy. (On section there was a small amount of golden yellow subcutaneous fat, and the musculature was reddish pink in color.) The peritoneal surfaces were smooth and glistening, and the cavity contained no fluid. The viscera were in normal relationship, and the right kidney was absent. The pleural cavities contained no fluid, but there were some adhesions at both apices and at the left base. The pericardial cavity contained about 25 c.c. of clear yellow fluid, and the surfaces were smooth.

Heart.—Weighed 200 gm. When the inferior vena cava was cut to remove the heart, a firm yellowish white mass entirely filling this blood vessel was encountered. The mass cut with great resistance and extended into the right auricle for 1 cm. The endocardium of all chambers was delicate, and all the valves were normal. The muscle was reddish pink in color and of normal thickness. *Histologically* the heart was normal.

Lungs.—Left weighed 280 gm.; right, 300 gm. Corresponding to the pleural adhesions in the left cavity there were two large, yellowish white, firm, tumor masses immediately beneath the pleura which measured 2 to 5 cm. in diameter. The rest of the lung was subcrepitant, and the color varied from a deep purple in the base to a pinkish gray in the upper lobe. The tumor masses cut with a great deal of difficulty and were sharply demarcated from the lung parenchyma. The cut section of the base of the left lung was wet, purple in color, and there were numerous firm, pinkish purple areas which were slightly granular in appearance. Similarly on the cut surface of the upper lobe, there were several firm, rusty pink, granular areas—apparently bronchopneumonia. The *right lung* contained three large tumor masses on the pleural surface, but these appeared to extend into the lung parenchyma, and they were not as well demarcated as those on the left lung. These tumors were similar in color and consistency to those on the left and measured 5 to 7 cm. in diameter. The lung varied in color from grayish white to a purplish red, and throughout the lobes there were numerous firm, red, granular areas. The bronchi of both lungs were slightly injected, and they contained some tenacious exudate. The pulmonary vessels were free from thrombi and emboli.

Microscopic section revealed the pleura to be uniformly thickened and in a few areas fibrin was present. Many alveoli near the pleural surface were collapsed, while in other areas they were of emphysematous proportions. In many areas, there was an exudate of polymorphonuclear leucocytes which filled the air cells while other alveoli were filled with fluid or large mononuclear phagocytic cells. In the areas containing tumor, the stroma was composed of wild appearing amorphous fibrous connective tissue in which were embedded the neoplastic cells. These cells tended to be spindle shaped or ovoid with granular, hyperchromatic nuclei. A rare mitosis was seen. Embedded in the stroma were long parallel fibers which resembled the connective tissue, yet which were so different as to be examined more carefully. Under high dry power these fibers proved to be striated musle. Sections stained with aniline blue and phosphotungstic acid stains showed these fibers to be present in striking abundance. Areas surrounding the tumor metastases showed vascular congestion and compression atelectasis.

The spleen, pancreas, gastrointestinal tract, and adrenals contained nothing of interest.

Liver.—Weighed 1,200 gm. The capsule of the liver was smooth and the color was brownish red. The cut surface had a boiled appearance, and the lobular architecture generally was indistinct. However, many central areas presented a congested red color. The biliary ducts and gallbladder were normal. Microscopically, areas surrounding the central veins showed a loss and necrosis of strands of liver cells, whose place was occupied by red blood cells. The medial coats of the central veins were much thickened. Portal structures were normal in appearance, and the rest of the liver cells showed cloudy swelling.

Kidneys.—Left weighed 98 gm.; right, absent. Except for compensatory hypertrophy, the left kidney was normal.

Pelvic Organs.—The bladder, uterus, tubes, and ovaries were normal in appearance.

Vascular System.—The aorta was normal. At the level of the right renal vein, the inferior vena cava contained a tumor mass which was of the same type found elsewhere in the vena cava. This tumor mass, although completely filling the inferior vena cava, did not extend into the left renal vein. Despite this neoplasm occluding the inferior vena cava, no ascites, edema, or other manifestations of occluded vascular supply could be found. Section through the tumor revealed its hard consistency, fleshy color, and pseudolobulated appearance. Histologically, the tumor in the inferior vena cava was composed of dense, overgrown connective tissue stroma in which were the neoplastic cells. These cells were spindle shaped, and a few were rod shaped. Their nuclei were granular and hyperchromatic. Mitotic figures were present. These neoplastic cells were smaller and less abundant than those in the lung metastases. In the interstices of the disordered pink stroma, distinct, pinkish red fibers were seen, occurring singly and in groups. Under higher magnifications, these fibers were identified as striated muscle. Aniline blue and phosphotungstic acid stains showed the muscle fibers to be abundant. (Fig. 3.)

Lymphatic System.—Nothing abnormal was noted except for some shotty cervical, axillary, and inguinal nodes. These showed lymphatic hyperplasia on microscopic section.

Neck Organs.—The thyroid was small, symmetrical, and otherwise not remarkable. The thymus was small.

Bone Marrow.—Sections of vertebral and rib marrows were pinkish red in color and quite cellular. The bone marrow was quite hyperplastic histologically, but the ratio of cells of the red and white series was normal. Many eosinophiles were present.

Brain.—Weighed 1,250 gm. and was normal on section.

DISCUSSION

A case is presented here in which the inferior vena cava was filled with tumor thrombus which extended into the right heart. Yet, from clinical symptoms there was no reason to suspect the thrombosis since there were no ascites, no edema, and no superficial venous engorgement. Therefore, one can reason that, as the thrombus grew in diameter as well as length, collateral venous circulation was completely established.

Striated muscle is not normal to the kidney, but the original kidney tumor contained areas of striated muscle. This is by no means uncommon as a review of the literature shows. It is uncommon, however, for metastases to carry along such differentiated structure as the stri-

ated muscle. As was seen in the microscopic sections, the muscle fibers in the lung metastases were as well differentiated as those described in the original tumor. Blau[1] reports a case of myosarcoma of the kidney of an adult in which the lung metastases contained striated muscle.

If our survey of the literature is correct, there are now six cases of thrombosis of the inferior vena cava by embryonic renal tumors, all involving the right kidney, two of which extended into the right heart.

While it is not uncommon for other renal tumors to extend into the vena cava, it seems that time so far has proved it to be an uncommon phenomenon in embryonal sarcomas of the kidney.

REFERENCES

1. Blau, A.: Ein Fall von Myosarcoma striocellulare renis, Koenigsberg, Liedtke, 1898.
2. Geschickter, C. F., and Widenhorn, H.: Am. J. Cancer **22**: 620, 1934.
3. McCurdy, G. A.: J. Path. & Bact. **39**: 623, 1934.
4. Merkel, H.: Ziegler's Beitr. z. path. Anat. **24**: 475, 1898.
5. Mixter, C. G.: Ann. Surg. **96**: 1017, 1932.
6. Sinkoe, S. J., Fowler, M. F., and Berger, L.: Am. J. Surg. **25**: 163, 1934.
7. Wilms, M.: Die Mischgeschwuelste, Leipzig, Georgi, 1899.

THE EFFECTS OF OBSTRUCTION OF THE COMMON BILE DUCT ON THE PORTAL BLOOD FLOW AND OXYGEN CONSUMPTION

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A METHOD was described recently by Blalock and Mason[1] which enables one to determine the blood flow and oxygen consumption of the liver and portal system of unanesthetized dogs. The method is a modification of one used by Mason, Blalock, and Harrison[2] for determining the renal blood flow and oxygen consumption. The present publication deals with the results of experiments in which the method was used for the study of the circulation of the portal system following occlusion of the common bile duct.

METHOD

Dogs were employed as the experimental animals. With the exception of several instances in which a small injection of morphine was given at the time of the control study, no anesthetic was used other than a small amount of novocaine which was introduced into the tissues overlying the external jugular vein at the site where the cannula was to be inserted. The animals exhibited no evidence of pain.

The principle of the method consists in producing temporary blockage of the inferior vena cava both above and below the entrances of the hepatic veins and in diverting the blood during this short period into a cannula which has been passed into the inferior vena cava through the external jugular vein. Samples of venous blood for oxygen consumption are obtained from the rubber tube attached to the external end of the cannula.

Five to ten days following the control studies, the common duct was divided between double ligatures near the duodenum. The omentum was fastened to the stump of the common duct. In some cases a small portion of common duct was excised in order to prevent the reestablishment of the duct. The gallbladder was not removed. The animals were again studied after the common ducts had been occluded for periods ranging from nine to twenty-six days. The icteric index was elevated, and the animals were markedly jaundiced at the time of the subsequent study.

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TABLE I

THE EFFECTS OF OBSTRUCTION OF THE COMMON BILE DUCT ON THE PORTAL BLOOD FLOW AND OXYGEN CONSUMPTION

EXPERIMENT NO.	CONTROL STUDIES					DAYS AFTER COMMON DUCT LIGATION								REMARKS
	WT. KG.	PORTAL BLOOD FLOW C.C. PER MINUTE	OXYGEN CONTENT VOLS. PER CENT		PORTAL O_2 CONSUMPTION C.C. PER MINUTE		WT. KG.	ARTERIAL B. P. M.M. HG.	PORTAL BLOOD FLOW C.C. PER MINUTE	OXYGEN CONTENT VOLS. PER CENT		PORTAL O_2 CONSUMPTION C.C. PER MINUTE	ICTERIC INDEX	
			ARTERIAL	HEPATIC VEIN						ARTERIAL	HEPATIC VEIN			
1	14.2	600	18.53	13.75	28.6	23	11.9		500	22.54	13.80	43.7	25	Complete obstruction. Marked dilatation ducts. Bile volume 70 c.c.
2	12.6	500	19.13	14.18	24.7	23	8.3	74	517	12.22	7.43	24.8	25	Complete obstruction. Dilatation ducts. Gallbladder scarred. Liver weight 395 gm.
3	12.0	600	18.52	13.80	28.2	23	9.5		546	18.10	9.71	45.8	12	Complete obstruction. Dilatation ducts. Bile volume 100 c.c. Liver weight 306 gm.
4	10.0	375	16.21	11.41	18.0	24	8.2	110	462	16.52	9.86	30.8	12	Dilatation ducts. Slight leakage ampulla. Liver weight 320 gm.
5	10.5	349				26	9.0	118	517	15.14	9.67	28.3	18	Complete obstruction. Dilatation ducts. Pressure in ducts 270 mm. H_2O. Liver weight 292 gm.
6	14.4	297	17.59	8.72	26.3	9	12.4	98	380	13.76	5.15	32.7	30	Not autopsied.
7	15.5	500				11	12.2	94	625	6.82	0.76	37.9	15	Liver weight 570 gm.
8	12.2	566	14.60	6.98	43.13	10	10.5	105	600	9.32	3.35	35.8	18	Liver weight 410 gm.

RESULTS

The data of eight experiments are given in Table I. At autopsy the gallbladders and hepatic ducts were markedly dilated and tense. In the one case in which a measurement was made, the intraductal pressure was 270 mm. water. In two experiments in which the volume of bile contained in the dilated extrahepatic biliary system was measured, 70 c.c. and 100 c.c. of bile were present.

DISCUSSION

It was recently reported by Levy, Mason, Harrison, and Blalock[3] that occlusion of the ureters causes a decrease in renal blood flow. The blood flow through the portal system is not decreased by complete obstruction of the common duct after several weeks of such obstruction. In six experiments, the blood flow increased an average of 85.3 c.c. per minute, or on an average of 27.3 per cent. In two experiments, the flows decreased on an average of 77.0 c.c. per minute, or 12.8 per cent. The oxygen consumption determinations showed more variations than the blood flows but indicated the same tendency to be increased rather than decreased. Of six experiments in which determinations of oxygen consumption were made, an increase was noted in four dogs after obstruction of the common duct. In one instance, the oxygen consumption was the same, and in only one experiment was it decreased.

Carr and Foote[4] reported that their dogs with common bile duct obstruction lived on an average of three and one-half months. The dogs lost weight gradually until about the beginning of the third month when the loss in weight was accelerated. The dogs in the present experiments also lost weight, an average of 2.4 kilos. The icteric indexes reported by Carr and Foote increased rapidly after operation until about the seventh week, when they either became stationary or decreased slightly. The icteric indexes in the present experiments were about a third less than the average maximum reported by Carr and Foote, and the degree of jaundice present was well tolerated by the animals. A few became moderately anemic, but none had any hemorrhagic manifestations.

SUMMARY

The blood flow and oxygen consumption of the portal area including the liver of unanesthetized dogs have been determined before and after occlusion of the common bile duct. The findings indicate that obstruction of the biliary system is not accompanied by a decrease in the blood flow and oxygen consumption of the portal system.

REFERENCES

1. Blalock, A., and Mason, M. F.: Observations on the Blood Flow and Gaseous Metabolism of the Liver of Unanesthetized Dogs, Am. J. Physiol. **117**: 328, 1936.
2. Mason, M. F., Blalock, A., and Harrison, T. R.: The Direct Determination of the Renal Blood Flow and Oxygen Consumption of the Unanesthetized Dog, Am. J. Physiol. (In press.)
3. Levy, S. E., Mason, M. F., Harrison, T. R., and Blalock, A.: The Effects of Ureteral Occlusion on the Blood Flow and Oxygen Consumption of Kidneys of Unanesthetized Dogs, SURGERY **1**: 238, 1937.
4. Carr, J. L., and Foote, F. S.: Progressive Obstructive Jaundice. Changes in Certain Elements of the Blood and Their Relation to Coagulation, Arch. Surg. **29**: 277, 1934.

CHOLECYSTOSCOPY

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WE WISH to draw attention to the possibilities of postoperative gallbladder inspection through a cholecystostomy stoma using a urinary bladder cystoscope. The purpose of the procedure is to find and remove stones left in the gallbladder or in the first part of the cystic duct.

We limit the use of cholecystostomy, as distinguished from more usual cholecystectomy, almost entirely to cases of empyema in aged, extremely ill, severely diabetic, or deeply jaundiced patients. We usually perform the operation through a small incision using local anesthesia. The uncertainty of the removal of all stones by blind instrumentation is demonstrated by their occasional appearance in the postoperative drainage and by their presence at subsequent cholecystectomy.

The advisability of removing all such stones can hardly be questioned. A stone impacted in the cystic duct will cause a mucous fistula. Removal of the stone will allow the fistula to close. After the operative stoma has closed, a stone may more readily promote a recurrent empyema, block the cystic duct, or pass into the common duct. A stone left free in the gallbladder may not cause trouble, but as an infected foreign body, it is undesirable.

The entire interior of the gallbladder and the orifice of the cystic duct are seen perfectly through a cystoscope. Stones are removed more easily than from the urinary bladder. Stones impacted at the entrance to the cystic duct can be dislodged and removed. Those impacted farther down the cystic duct cannot always be removed by this method. The possibilities of instrumentation of the common duct to remove common duct stones, or to dilate the ampulla of Vater, immediately come to mind. This we have not attempted. In an exceptional case it might be possible, though it has impressed us as being too blind a procedure, and when indicated, more hazardous than regular operation.

We employ the following technique in performing this examination. At the time of operation, the gallbladder is emptied as well as possible. A drain is placed into the gallbladder and other drains around it. In the course of the following week, all drains are removed, that into the gallbladder usually last. Cystoscopic examination is done as a bedside procedure, immediately after the removal of this drain. Attempt to use the cystoscope at the original operation is unsuccessful due to poor vision and the spilling of water into the free peritoneal cavity. After removing

the drain, a small catheter is inserted down the tract, and salt solution is allowed to run in and out until it returns clear. A McCarthy foroblique pan-endoscope is then inserted along this catheter. It is unnecessary and unwise to distend the gallbladder with fluid. The orifice of the cystic duct and the entire inner wall of the gallbladder are seen perfectly. Remaining stones are usually small and can be removed with forceps either through the cystoscope or behind it as the cystoscope is withdrawn. The sinus tract at this time is sufficiently large to permit the removal of all stones we have encountered. The procedure is simple and painless. Doubtless other types of water cystoscopes can be used and perhaps direct vision instruments such as the Kelly air cystoscope or a bronchoscope.

THE USE OF METYCAINE IN SPINAL ANESTHESIA

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METYCAINE, or gamma(2-methylpiperidin)-propylbenzoate hydrochloride, is a derivative of cocaine belonging to the substituted piperidin series. It was first prepared by McElvain, in 1927, and is notable for its action as a local and topical anesthetic agent. In comparison with cocaine, metycaine and other substituted piperidin derivatives are about a fourth as toxic as is cocaine, and, in addition, they possess considerable anesthetic power. Meeker and McCreary, who have compared the anesthetic potency of procaine and metycaine by means of intradermal injection, found that anesthesia which was induced with 0.0625 per cent solution of procaine without epinephrine lasted five minutes; whereas, anesthesia which was induced with an equal amount of 0.0625 per cent solution of metycaine lasted fourteen minutes. Romberger and Walther also confirmed the observation of Meeker that anesthesia which is induced with metycaine is more enduring than that which is induced with procaine. The toxicity of metycaine and procaine has been studied by Rose and others, whose results indicate that metycaine is no more toxic than procaine.

Since metycaine is a topical anesthetic, it has been advocated as a local anesthetic agent for mucous membranes, especially for genitourinary instrumentation. The usual strength of the solution for this type of work in the urethra or bladder, or for instillation in the eye, has been 2 to 4 per cent. For regional anesthesia, other than spinal anesthesia, a 0.5 to 2 per cent solution is used, depending on the type of nerve block or on the tissue to be anesthetized.

Concerning the use of metycaine for spinal anesthesia, Woodbridge and Romberger have reported satisfactory results in a limited number of cases. Both of these workers expressed the opinion that metycaine is definitely more potent than procaine, and that adequate anesthesia can be obtained with slightly smaller doses of the former agent. In the series of cases observed at the Mayo Clinic, a 10 per cent solution of metycaine in distilled water was used. Each cubic centimeter of the solution contained 100 mg. of metycaine. The patients to whom metycaine was administered were considered as suitable risks for spinal anesthesia. As an aid in determining when to use spinal anesthesia, certain criteria were adhered to closely regardless of the anesthetic agent to be used. Debility, which connotes marked physical weakness, was con-

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sidered a definite contraindication to the use of spinal anesthesia. Likewise, when the value for the hemoglobin was very low or when marked hypotension was present, spinal anesthesia was definitely considered to be contraindicated.

The technique used for spinal anesthesia in this series was uniform. The patients received premedication the evening prior to operation, which usually consisted of the administration of 1½ to 3 gr. (0.1 to 0.2 gm.) of pentobarbital sodium (nembutal) by mouth. One hour before operation, 1½ to 3 gr. (0.1 to 0.2 gm.) of pentobarbital sodium was administered by mouth and ⅙ to ¼ gr. (0.01 to 0.016 gm.) of morphine sulphate was given hypodermically. If general inhalation anesthetics were to be administered as a supplement to spinal anesthesia, atropine sulphate, gr. $\frac{1}{200}$ to $\frac{1}{150}$ (0.0003 to 0.0004 gm.) usually was administered with the morphine. Ephedrine sulphate was injected intramuscularly in practically all cases at the time the spinal anesthetic was administered. In some cases of moderate hypertension, the injection of ephedrine was delayed until after the spinal puncture had been made. This was done to prevent an untoward elevation in systolic blood pressure in the event the subarachnoid injection could not be readily accomplished. In the average case, ⅜ to ¾ gr. (25 to 50 mg.) of ephedrine was used, the former dosage being used in those cases in which the blood pressure was normal, and the latter in cases in which there was moderate hypotension or when larger dosages of the anesthetic were used. In no case was more than 1 mg. of metycaine per pound of body weight administered.

METHOD OF ADMINISTRATION

Injections were made while the patients were lying on the right side and while the table was in the horizontal position. Occasionally, because of excessive obesity or arthritic complications, the injection was made while patients were in the sitting position. For upper abdominal operations the first and second lumbar interspaces were used; the second and third lumbar interspaces were used in midabdominal operations; and the third and fourth lumbar interspaces were used in pelvic operations or in operations on the extremities. The lumbar puncture needles which were used were 21-gauge needles with short pointed bevels.

The factors which influence the duration of anesthesia and degree of relaxation are: (1) the dose of the anesthetic agent; (2) the site of injection; (3) the volume of spinal fluid withdrawn, in which the dose of the anesthetic agent is diluted. In our experience at the clinic, we have found that a concentration in the syringe of 3 to 5 per cent of metycaine or procaine in spinal fluid gives the most satisfactory anesthesia. For example, 120 mg. of metycaine diluted with 4 c.c. of spinal fluid in the syringe makes approximately a 3 per cent solution. Concentrations

greater than 5 per cent do not improve the efficiency of anesthesia, and concentrations less than 3 per cent usually produce inadequate anesthesia. Barbotage is not used and the rate of injection is maintained at 0.5 c.c. per second.

ANALYSIS OF CASES

This analysis is based on a study of 600 cases in which metycaine was administered to produce spinal anesthesia.

TABLE I

OPERATIONS ON THE KIDNEY (44 CASES)

DOSE (MG.)	CASES		AVERAGE BLOOD PRESSURE, MM. OF MERCURY				AVERAGE FALL IN BLOOD PRESSURE		DURATION OF OPERATION AVERAGE IN MINUTES	ADDITIONAL ANESTHESIA	MISCELLANEOUS DATA
			BEFORE OPERATION		AFTER OPERATION						
	NUMBER	PER CENT	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC			
100-125	9	20.5	120	75	101	63	19	12	59	4	0
130-145	14	31.8	123	75	106	63	17	12	54	1	Nausea 2 Headache 2
150-165	21	47.7	128	77	106	67	22	10	57	4	Nausea 9 Headache 1

TABLE II

OPERATIONS ON HIP JOINT AND LOWER EXTREMITIES (43 CASES)

DOSE (MG.)	CASES		AVERAGE BLOOD PRESSURE, MM. OF MERCURY				AVERAGE FALL IN BLOOD PRESSURE		DURATION OF OPERATION AVERAGE IN MINUTES	ADDITIONAL ANESTHESIA	MISCELLANEOUS DATA
			BEFORE OPERATION		AFTER OPERATION						
	NUMBER	PER CENT	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC			
50- 90	2	4.6	128	78	120	75	8	3	78	0	0
100-125	16	37.2	125	74	113	63	12	11	44	2	Nausea 2 Headache 1
130-145	14	32.5	128	73	114	67	14	6	51	3	Nausea 4
150-155	11	25.5	144	98	115	65	29	33	71	0	Nausea 4 Headache 1

As a means of analyzing the data from the standpoint of type of operation, various classifications of surgical operations were made and the total number of cases in each group was studied. The doses of metycaine, the number and percentage of cases, the average values for the blood pressure (systolic and diastolic) before and after operation,

the average decrease in both the systolic and diastolic blood pressure, the duration of the operation, additional anesthetic employed, and miscellaneous observations were recorded in Tables I to VII. The age, weight, height, and general physical condition of the patient and the value for the hemoglobin were noted and approved in each case prior to the administration of the spinal anesthetic.

TABLE III

OPERATIONS ON GENITOURINARY TRACT (53 CASES)

DOSE (MG.)	CASES		AVERAGE BLOOD PRESSURE, MM. OF MERCURY				AVERAGE FALL IN BLOOD PRESSURE		DURATION OF OPERATION AVERAGE IN MINUTES	ADDITIONAL ANESTHESIA	MISCELLANEOUS DATA
			BEFORE OPERATION		AFTER OPERATION						
	NUMBER	PER CENT	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC			
60- 90	8	15.1	133	80	118	60	15	20	27	0	Headache 1
100-125	17	32.1	128	76	117	67	11	9	42	1	Nausea 1
130-145	19	35.9	133	79	115	69	18	10	45	4	Nausea 3 Headache 2
150-155	9	16.9	131	80	96	65	35	15	78	1	0

TABLE IV

OPERATIONS FOR HERNIA (74 CASES)

DOSE (MG.)	CASES		AVERAGE BLOOD PRESSURE, MM. OF MERCURY				AVERAGE FALL IN BLOOD PRESSURE		DURATION OF OPERATION AVERAGE IN MINUTES	ADDITIONAL ANESTHESIA	MISCELLANEOUS DATA
			BEFORE OPERATION		AFTER OPERATION						
	NUMBER	PER CENT	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC			
45- 95	2	2	145	83	108	60	37	23	58	0	Headache 1
100-125	6	8	134	80	124	74	10	6	50	0	Headache 1
130-145	38	51	133	79	112	67	21	12	62	3	Nausea 4 Headache 3
150-160	29	39	149	78	108	63	41	25	63	4	Nausea 8 Headache 1

Spinal anesthesia was considered satisfactory in 479 of the 600 cases studied. Additional anesthesia was employed in 121 cases; in 110 of these cases, spinal anesthesia was intentionally combined with inhalation anesthesia, either at the request of the patient or surgeon. In the remaining 11 cases, the spinal anesthetic was inadequate. Lumbar

puncture headache or its equivalent, which was present in 23 cases (3.83 per cent), ranged from mild to severe in type and duration.

From the assembled data it is significant that the incidence of nausea associated with vomiting was most prevalent in operations on the upper

TABLE V

OPERATIONS ON THE UPPER PART OF THE ABDOMEN (53 CASES)

DOSE (MG.)	CASES		AVERAGE BLOOD PRESSURE, MM. OF MERCURY				AVERAGE FALL IN BLOOD PRESSURE		DURATION OF OPERATION AVERAGE IN MINUTES	ADDITIONAL ANESTHESIA	MISCELLANEOUS DATA
			BEFORE OPERATION		AFTER OPERATION						
	NUMBER	PER CENT	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC			
100-125	9	16.9	138	76	99	59	39	17	46	6	Vomiting 1
130-145	26	49.0	130	75	103	65	27	10	62	18	Vomiting 1 Nausea 5
150-155	16	30.1	133	82	101	65	32	17	50	12	Vomiting 1 Nausea 2 Headache 1
160-180	2	3.7			115	73			49	2	0

TABLE VI

OPERATIONS ON THE LOWER PART OF THE ABDOMEN (144 CASES)

DOSE (MG.)	CASES		AVERAGE BLOOD PRESSURE, MM. OF MERCURY				AVERAGE FALL IN BLOOD PRESSURE		DURATION OF OPERATION AVERAGE IN MINUTES	ADDITIONAL ANESTHESIA	MISCELLANEOUS DATA
			BEFORE OPERATION		AFTER OPERATION						
	NUMBER	PER CENT	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC			
60- 90	2	1.4	123	73	120	50	3	23	47	1	0
100-125	67	46.5	129	73	107	65	22	8	38	28	Vomiting 2 Nausea 3 Headache 3
130-145	63	43.7	136	78	111	69	25	9	46	23	Nausea 4 Headache 1
150-155	12	8.3	152	83	108	63	44	20	70	4	Nausea 3

part of the abdomen and its incidence increased as the dose of the spinal anesthetic agent was increased to the neighborhood of 150 to 160 mg. Another factor which probably increases the incidence of nausea and vomiting in operations on the upper part of the abdomen is the usual

manual manipulation in the region of the stomach. The occurrence of nausea per se is extremely difficult to evaluate in many instances because of various psychic influences associated with operations under this form of regional anesthesia.

An analysis of the values for the systolic and diastolic blood pressure, which were obtained before, during, and after the induction of spinal anesthesia, is interesting in this particular study, because it emphasizes the rather universal belief that as the dose of the anesthetic agent is increased the probability of a greater fall in the blood pressure, especially in the systolic blood pressure, is enhanced. The average fall in systolic blood pressure in these cases was very slight and in only a few instances was it necessary to elevate blood pressure by stimulants such as ephedrine or epinephrine.

TABLE VII

TRANSURETHRAL PROCEDURES (189 CASES)

DOSE (MG.)	CASES		AVERAGE BLOOD PRESSURE, MM. OF MERCURY				AVERAGE FALL IN BLOOD PRESSURE		DURATION OF OPERATION AVERAGE IN MINUTES	ADDITIONAL ANESTHESIA	MISCELLANEOUS DATA
			BEFORE OPERATION		AFTER OPERATION						
	NUMBER	PER CENT	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC	SYSTOLIC	DIASTOLIC			
50- 55	2	1.1	133	73	118	70	15	3	35	0	0
60- 65	35	18.5	136	75	132	74	4	1	50	0	Nausea 11 Headache 1
70- 75	24	12.7	135	70	127	70	8	0	36	0	Nausea 5
80- 85	105	55.6	135	78	127	74	8	4	42	0	Vomiting 1 Nausea 29 Headache 2
90-100	23	12.1	136	80	128	74	8	6	37	0	Nausea 4 Headache 1

In this series of cases it was also found that the doses of metycaine used for various operations compared favorably with other anesthetic agents which are used at the clinic. It is my impression that metycaine is no more toxic than is procaine in spinal anesthesia, and that the effect of metycaine lasts equally as long as, if not longer than, does the effect of procaine. A larger series of cases will have to be studied in order to make any definite conclusions in regard to this particular feature. No fatalities which could be attributed to the anesthetic agent used occurred in this series of cases.

SUMMARY

Six hundred cases were studied in which metycaine was used for spinal anesthesia. Various data and conclusions are given regarding its usefulness as a spinal anesthetic.

REFERENCES

1. Lundy, J. S., and Tuohy, E. B.: Regional Anesthesia, Med. Rec. and Ann., 1936.
2. McElvain, S. M.: Piperidine Derivatives: IV. Substituted Piperidine-Alkyl Benzoates and Para-Aminobenzoates, Am. Chem. Soc. Jour. **49**: 2835-2840, 1927.
3. Meeker, W. R., and McCreary, P. L.: Metycaine in Spinal Anesthesia, Am. J. Surg. **24**: 139-141, 1934.
4. Romberger, F. T.: Comparative Scope and Clinical Utility of Various Agents and Techniques in Spinal Anesthesia, Current Researches in Anesth. & Analg. **12**: 152-155, 1933.
5. Rose, C. L., Coles, H. W., and Thompson, Helen E.: Studies in the Pharmacology of Local Anesthetics: III. Comparison of Gamma-(2-Methyl Piperidino)-Propyl Benzoate Hydrochloride With Cocaine and Procaine on Experimental Animals, Jour. Lab. & Clin. Med. **15**: 731-735, 1930.
6. Walther, H. W. E.: A New Surface Anesthetic in Urology, J. Urol. **27**: 119-121, 1932.
7. Woodbridge, P. D.: Neothesin for Spinal and Regional Anesthesia: A Preliminary Clinical Report, Current Researches in Anesth. & Analg. **11**: 177-183, 1932.

THE EFFECT OF SYMPATHECTOMY ON PERIPHERAL VASCULAR DISEASE

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THE use of sympathectomy in certain forms of peripheral vascular disease is a controversial matter. Ever since Adson, of the Mayo Clinic, and Diez, of Buenos Aires, simultaneously advocated this operation to improve peripheral circulation, a voluminous literature developed around this subject. Scupham and I[1] reviewed the pertinent literature in 1935 and 1936, and no attempt will be made here to discuss previous work. The purpose of this presentation is to summarize the observations made by myself and my associates on patients who were subjected to sympathectomy for peripheral vascular disease. Some of the subject matter will be published in more detail by my coworkers Ford K. Hick and William Beck.

So far this operation has been performed in my clinic for selected cases of Raynaud's disease, Buerger's disease, poliomyelitis with vasospastic phenomena, reflex dystrophy of the extremities, and a group of unclassified cases which exhibit Raynaud's phenomenon. Common to all of these groups should be a demonstrable capacity of the peripheral vascular bed to dilate. Whether such preoperative tests are made by the production of fever, by reflex dilatation to heat, with spinal anesthesia or with peripheral or paravertebral nerve block, depends mostly on the choice of the operator. We have used all these tests in my clinic for several years. At this time I wish to present another test, which, while it does require the possession of an oscillometer, has two great advantages: it can be performed on ambulatory patients, and it does not require readings of surface temperatures, which are of absolute value only when taken in rooms of constant, controlled temperature and humidity. The test consists of the determination of an oscillometric curve at the distal part of the extremity, which is followed by an intravenous injection of 1 c.c. of a 4 per cent solution of sodium nitrite. This dose and concentration have proved harmless in a series of over one hundred injections undertaken by William Beck and myself. From ten to fifteen minutes after intravenous injection, the peak of vasodilatation may be observed, but the effect may last as long as one hour. We have taken a reading at the end of ten to fifteen minutes to demonstrate the ability of the peripheral vascular bed to dilate. A few graphs may serve to illustrate such records. While it does not imitate the effect of sympathectomy as closely as a paravertebral injection of the sympa-

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thectic ganglia, it demonstrates the ability of a drug to open up whatever channels are available and is thus a true index of collateral reserve. (Figs. 1 and 2.)

We do not wish to imply that with no increase of pulsations following sodium nitrite, sympathectomy is of no avail. I will be able to show a little later that even in such cases it may be sufficient to turn the scale

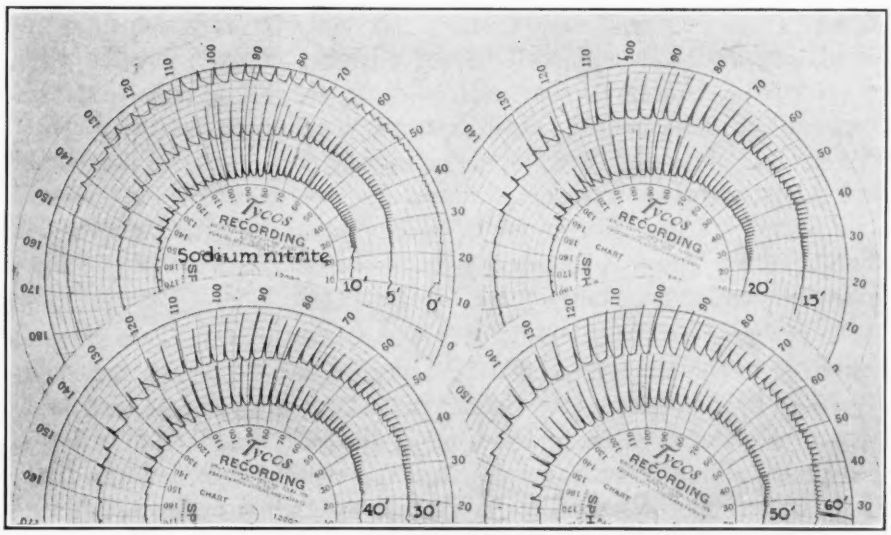

Fig. 1.—A. K., twenty-three-year-old woman suffering from Raynaud's disease. At 0 minutes, an oscillometric tracing was obtained with a recording sphygmotonometer at the ankle. Immediately after that 1 c.c. of a 4 per cent sodium nitrite solution was injected intravenously. Tracings were obtained at 5, 10, 15, 20, 30, 40, 50, and 60 minutes after the injection. Note that the maximal oscillations were obtained at 15 minutes. The systolic blood pressure remained constant between 150 and 140 mm. throughout the test. The diastolic pressures varied between 60 and 70 mm. There occurred a rise to 90 mm. at 50 and 60 minutes. Note the shift of the spikes to the right at 15 minutes indicating decreased peripheral resistance. This case seemed suitable for sympathectomy.

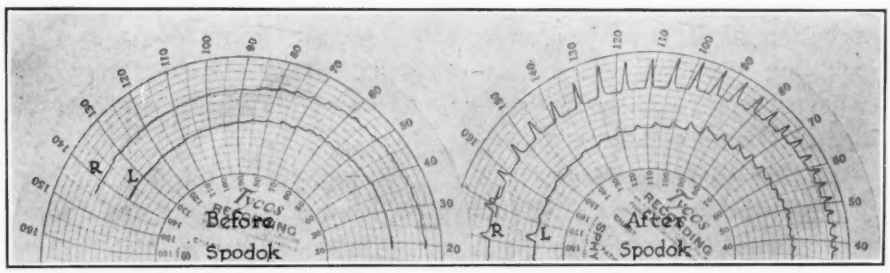

Fig. 2.—J. S., twenty-one-year-old dental student suffering from Buerger's disease. The left leg showed clinical signs and symptoms of vascular occlusion. Before sodium nitrite both lower extremities showed a marked vessel spasm. Fifteen minutes after sodium nitrite, the vessels of the left foot showed slight vasodilatation, while those of the right opened up widely. Double cuffs were used at both ankles.

from impending gangrene to rapid healing of ulcers and to restore the ability to do a limited amount of work.

The indications for sympathectomy vary so much according to the different types of circulatory disorders and are guided so closely by the results obtained in the individual disease that it was thought best to discuss them separately according to the preoperative diagnosis.

PATIENTS EXHIBITING RAYNAUD'S PHENOMENON

In a recent excellent review, John H. Hunt[2] defines Raynaud's phenomenon as intermittent pallor or cyanosis of the extremities precipitated by exposure to cold without clinical evidence of blockage of the large peripheral vessels and with nutritional lesions, if present at all, limited to the skin. While this phenomenon is seen frequently, true Raynaud's disease really can be diagnosed only by exclusion of many circulatory disorders with well-defined etiology. This is not the place to enter into differential diagnostic criteria, except to state that true Raynaud's disease is rare. In this series a diagnosis of this malady was made in six cases. This number seems small; however, Hunt could find only thirty cases among five hundred references in the English and American literature since Raynaud's description appeared seventy-five years ago. Only one of Raynaud's thirty-one cases corresponds to what one would understand now by Raynaud's disease.

For the analysis of the results, it is convenient to group these patients according to the stage in which the operation has been undertaken, as suggested by Paterson Ross.[3] In the first stage, there are no detectable structural changes in the arteries or in the soft tissues of the digits. The vessels dilate fully, when relaxation is obtained, by heating parts of the body. In the second stage, there is ulceration of the finger tips or painful stellate scars at the end of slightly tapering digits. Reflex dilatation to heat produces only a slow and incomplete rise in temperature. In the third stage, patients have advanced structural disease of the arteries. The fingers will fail to heat up when heat is applied to the lower extremities. They suffer from a diffuse sclerosis of the digits involving skin, joints, and tendons, a sclerodactylia secondary to an advanced Raynaud's disease. This last group hardly fits into the classic conception of Raynaud's disease, but there can be no doubt that in examining the four extremities of a patient exhibiting Raynaud's phenomenon, frequently at least two stages of the disease are encountered in the same individual.

Granting that the diagnosis is correct and the surgical procedure adequate, the stage of the disease in which the operation was undertaken affected the results in the following manner: in the first stage of the disease, the late results have been excellent; in the second stage, the hand may become cold again and arterial spasms may return, but the progress of the disease is arrested and the attacks are less frequent. Patients in this group feel that they have benefited from the operation, but the result is not as dramatic as in the first group. In the third stage, the late results are poor; and a year or two after the operation the condition of the hands is no better than before. While in the first two groups the operation has been of decided benefit, in the third stage it is useless. Equally, or perhaps even more, important is the type of

operation performed. On the lower extremity, the typical lumbar sympathectomy, removing the chain and intervening ganglia from the second to including the fourth lumbar segment, has been uniformly successful in all statistics and also in our experience. In the lower extremities, Raynaud's disease hardly ever progresses beyond the first stage. On the upper extremity, however, we have encountered failures even in the earlier stages of the disease, as long as we followed the procedure of Adson, namely, the removal of the inferior cervical and first and second thoracic ganglia. Since, based on the work of Freeman, Smithwick, and White, Telford first suggested leaving these ganglia intact and performing a preganglionic section, which separates the last cell stations from the cord, results have been vastly improved. I have four patients now suffering from Raynaud's disease, in whom preganglionic section has been performed on one upper extremity and postganglionic on the other. The contrast between the two sides is striking. There is still, however, a group of cases, in which residual sweating remains, and in which fibers must have been missed. Of our four preganglionic sections done for Raynaud's disease, the results are excellent in three and only fair in one. In this case, residual sweating indicates that the operation has not been complete (Table I).

TABLE I

RESULTS OF SYMPATHECTOMY IN RAYNAUD'S DISEASE

Sixteen Sympathectomies on Six Patients*

CASE NO.	NAME	DURATION	STAGE	OPERATION		RESULT		REMARKS
1	W. F.	3 years	2	Preganglionic	1	Fair	1	
				Postganglionic	1	Failure	1	
2	N. S.	8 years	3	Postganglionic	2	Failure	2	Residual sweating
3	A. M.	6 years	2	Preganglionic	1	Excellent	3	
				Postganglionic	1	Failure	1	Brachial neuritis, 6 weeks
				Lumbar	2			
4	A. J.	1 year	2	Preganglionic	1	Excellent	1	
				Postganglionic	1	Fair	1	
5	P. Z.	10 years	2	Preganglionic	1	Excellent	1	Brachial neuritis, 4 mo.
				Postganglionic	1	Fair	1	
6	K. S.	8 years	3	Postganglionic	2	Fair	2	
				Lumbar	2	Excellent	2	

*Patients in this series have been followed through at least one winter, three of them through two winters. By fair result is meant definite improvement, fewer or shorter attacks, but not complete relief.

From these results, the following indications for sympathectomy in Raynaud's disease have been formulated: (1) the operation must be undertaken during the first or second stage of the disease—later it is useless; (2) lumbar sympathectomy is less frequently indicated, but it invariably gives good results; (3) cervicothoracic sympathectomy has been abandoned and a transection of the thoracic sympathetic chain and of the second and third white rami substituted. This method gave excellent results in three cases and fair results in one case.

Based on this experience, we do not advocate sympathectomy in the late stages of Raynaud's disease nor do we perform a typical cervicothoracic ganglionectomy any more.

BUERGER'S DISEASE

Ten patients had twenty-two sympathectomies in this series. It is not possible to classify these patients so readily into groups of early, advanced, and late stages, since one patient frequently exhibits different stages of the disease in different extremities or even in the same extremity. The ten patients were selected out of a series of 125 suffering from Buerger's disease, and even in this restricted number of cases, two patients should not have had a sympathectomy according to our present indications. Since our first sympathectomy done in 1929 for Buerger's disease, the indications have slowly crystallized, and at present, the following method of selection is adopted: Every patient diagnosed as having Buerger's disease is first put on a nonsurgical management, including abstinence from tobacco, high calcium and low potassium diet, plenty of water, and small subreactionary doses of typhoid vaccine. Foci of infection are removed. If the patient is in an acute inflammatory stage, two to three weeks of bed rest are enforced. Meanwhile, the capacity of the vascular bed to dilate is tested by reflex heat and more recently by sodium nitrite. If the vascular tree is flexible, if the patient is under forty years of age, and if no acute inflammatory changes are present and no evidence of visceral involvement of the vessels is detectable, a sympathectomy is advised, unless a marked clinical improvement has taken place under conservative management.

Our patients have been followed from month to month after sympathectomy, and the following observations have been made: In contrast to Raynaud's disease, sympathectomy is especially helpful on the upper extremity; it should be urged in patients who have already lost one or two of their lower extremities and whose radial or ulnar pulses are absent or who have lost some phalanges. The use of the fingers is remarkably enhanced following this operation. On the lower extremity, coldness and numbness and rest pain are greatly influenced in the well-selected case, while intermittent claudication is not or is slightly improved (Table II).

The questions that arise immediately are: (1) Is the progress of the disease arrested, and (2) is a subsequent vascular occlusion better tolerated? From the survey of the literature it would seem that the disease can and does progress following sympathectomy. I have seen a few patients who suffered subsequent thromboses in a sympathectomized limb. One cannot be too emphatic in stating to the patient that the entire array of conservative management prescribed before the operation must

TABLE II

THE RESULTS OF SYMPATHECTOMY IN BUERGER'S DISEASE

Twenty-Two Sympathectomies on Ten Patients

CASE NO.	NAME	AGE	OPERATION		EFFECT OF*				REMARKS
					COLDNESS AND NUMBNESS	CLAUDICATION	REST PAIN	ULCERATION	
1	J. H.	48	Lumbar	2	0	0	0		Died fifth day, coronary occlusion
2	M. V.T.	31	Preganglionic	2	+++	+	+++		Excellent
3	S. S.	36	Lumbar	2	+++	0	++	+++	Excellent
4	S. L.	39	Lmbar	2	+++†	+	+++		Excellent
5	F. N.	38	Preganglionic	2	+++	++			Fair on lower;
			Lumbar	2	-	0	+++		excellent, upper
6	A. T.	35	Preganglionic	1	+++	0	++		Bilateral amputation
			Lumbar	2	0	0	0		
7	A. R.	36	Preganglionic	1	+++	+	+++		Excellent
8	G. G.	30	Preganglionic	1	+++		+++		
			Lumbar	1	+++	+	+++		Excellent
9	J. A.	31	Lumbar	2	+++	-	+++		Fair
10	J. D.	28	Lumbar	2	+++	+	-		Excellent

*Legends +++, complete relief; ++, greatly improved; +, better; 0, no effect; and -, absent before operation. Claudication gauged according to ability to walk at a rate of ten paces in five seconds until cramping occurs.

†Peripheral nerve crushing produced this result.

be followed after the operation for many months or years. In addition, certain measures which are rather ineffective in Buerger's disease before sympathectomy can now be used with benefit, because the vasomotor paralysis decreases the resistance to the stretching of the vessels and promotes reactive hyperemia. I am referring to treatments by suction and pressure and another method, alternate venous compression and release, which my coworkers and I have recently found to be especially efficacious and conveniently used in the home.[4] The advantages of a sympathectomy in Buerger's disease are as follows: In the well-selected case, there is a striking improvement of the nutritional state of the fingers or toes; ulcers heal, and the edema subsides. Should a sudden thrombosis of a larger vessel occur later, it will not evoke a massive reflectoric vessel spasm as this sensory-sympathetic reflex is interrupted on the efferent side. But claudication will not improve after sympathectomy unless subsequent vascular exercises are capable of enlarging a very limited vascular bed. Sympathectomy in Buerger's disease is of little avail when thrombosis is too widespread so that improvement of circulation is mechanically impossible. Such patients will not open their vessels after administration of sodium nitrite, and their venous oxygen saturation, as discussed later, does not rise after sympathectomy. In doubtful cases, paravertebral injections of alcohol may be attempted, which imitate, at least for several months, the effects of sympathectomy

but which may be readily performed on ambulatory patients. William Beck will report on our experience with this method. Finally there remains in cases with intractable rest pain and a fixed vascular bed incapable of dilatation the crushing of the sensory nerves to the foot. We have seen considerable and often complete relief from this method in twenty-eight cases, but we are recently more and more reluctant to perform this procedure except on bedridden patients with continuous excruciating pain. The interruption of the sensory fibers destroys the important axon reflexes which protect the tissues from external injury, and so-called "trophic" ulcers may develop over pressure-points of the foot which do not respond with reactive hyperemia to injury.

Since Buerger's disease is seen and operated on earlier, the results have been very much better; it is true that a remission may occur after many weeks of rest in bed, but a powerful impetus to remission is afforded by sympathectomy in a short time.

ANTERIOR POLIOMYELITIS WITH VESSEL SPASM

Out of a group of twenty-five children, from E. W. Ryerson's service, nine have been selected for sympathectomy. Of the nine, three patients have now gone through two winters and only these will be reported. They were studied by George Scupham with the help of Johnson's plethysmograph. The cold, painful, plum-colored extremities have retained an increased vascularity. They have not shown an increased growth after operation, but in one child, the rate of growth now is equal with that of the unaffected side. The type of patient who will be benefited by sympathectomy has been described by Harris and MacDonald[5] as follows: In a child, preferably not older than eight years of age, if the paralysis is limited to one extremity and is moderate in degree, a sympathetic ganglionectomy will maintain an increased vascularity of the extremity and can result in accelerated growth. In my material, the children were between ten and sixteen years of age, and possibly not much growth can be expected when the limb is hopelessly paralyzed and when the normal stimulus following use and exercise is lacking. The reflex dilatation to heat is normal in these children, and yet nodular patches, cyanosis, edema, and chilblains are apparent in a certain group of cases. This condition rapidly improves after sympathectomy which should be done more often and earlier than it has been done before.

REFLEX DYSTROPHY OF THE EXTREMITIES

In some yet unpublished work,[6] I have suggested that acute bone atrophy, traumatic osteoporosis, stump neuroma, and causalgia are fundamentally identical vasomotor and nutritional disturbances, which occur after

mild soft tissue injuries, infections, venous and arterial thromboses, and fractures. This syndrome is characterized by shiny, swollen fingers and toes, stiffness of joints, a spotty atrophy of bone, and marked sensitivity to heat and cold. Paroxysms of pain may be evoked by fright, unexpected noises, any emotional state, or pressure on certain trigger zones. Conservative measures such as heat, massage, and diathermy fail in the severe cases. Psychotherapy is often needed because these patients are mostly neurotic and have a low intelligence quotient. The otherwise intractable cases, which have often come to amputation, may be relieved by sympathectomy. If a local source of irritation, such as a perineuritis around the median or sciatic nerve, a periphlebitis or a stump neuroma, cannot be found and removed, the reflex can be interrupted on the ef-

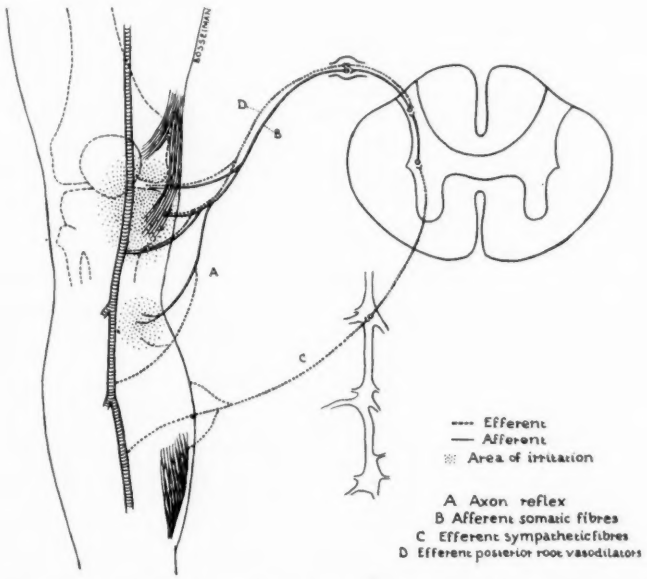

Fig. 3.—The reflex pathways operating in reflex dystrophies. Vasomotor and nutritional reflexes originating in the tissues. Clinical experience would indicate that such stimuli are especially apt to originate around blood vessels, joints, and tendons.

ferent side by a sympathectomy. In five such intractable cases, I have obtained excellent results.

The concept of regarding many of the vasomotor phenomena as an activation of a sensory-sympathetic reflex is very fruitful in explaining the benefits of sympathectomy in Buerger's disease and in reflex dystrophies. As W. J. Merle Scott[7] pointed out, the irritation of sensory fibers around diseased or obstructed vessels is the origin of afferent impulses which cause a marked vasoconstrictor reflex. This vasoconstriction extends not only over the diseased vessel but as well to the anastomotic and terminal vessels on which the viability of the extremity distal to the obstruction depends (Fig. 3).

DISCUSSION

An interpretation of the benefits from sympathectomy in such vastly different disorders as Raynaud's disease, Buerger's disease, poliomyelitis with vessel spasm, and reflex dystrophy can be based only on objective findings elicited on patients whose one or several limbs have been sympathectomized. To date, a direct measurement of blood flow in man, such as Rein's Strohmuhr in the experimental animal, has not been reported. However, the arteriovenous oxygen difference is a good index of blood flow through the extremity, provided metabolism is unchanged. This method has been used extensively by Lennox[8] in his studies on cerebral circulation and by Weiss and Ellis[9] in the extremities. Ford K. Hick and I studied four sympathectomized patients before, few weeks after, and several months after the operation as to their venous oxygen saturation which most clearly reflects the oxygen tension of the tissues. Patients with peripheral vascular disease obviously suffer from a relative tissue anoxia, and if this can be relieved or improved by sympathectomy, objective evidence for an improved tissue nutrition has been obtained. While the data presented in the table (Table III) are only of prelim-

TABLE III

THE EFFECT OF SYMPATHECTOMY ON VENOUS OXYGEN CONTENT AND SATURATION

CASE NO.	DIAGNOSIS	SIDE	BEFORE OPERATION OXYGEN		2 WEEKS AFTER OXYGEN		SEVERAL MONTHS AFTER OXYGEN	
			CONTENT	SATURATION	CONTENT	SATURATION	CONTENT	SATURATION
1	Buerger's disease	L	11.75	61.4	8.46	45.8	9.02	48.4
	S. L.	R	6.93	36.3	8.85	47.5	9.53	50.9
	O_2 capacity		19.1		18.46		18.70	
2	Buerger's disease	L	11.63	62.9	12.68	77.4	11.90	79.0
	F. N.	R					6.62	44.0
	O_2 capacity		18.48		16.36		15.05	
3	Buerger's disease	L	16.00	83.7			15.9	90.8
	J. G.							
	Arms	R	14.90	77.4			15.2	85.7
		L			10.92	62.4		
	Legs	R			12.66	72.4		
4	Raynaud's disease	L	7.87	42.5	15.86	83.0	10.92	60.4
	A. J.							
	Arms	R			13.60	73.6	12.74	70.4
		L	9.88	46.7			11.05	76.2
	Legs	R	7.92	58.4			8.47	58.4
	O_2 capacity		16.93		19.10		18.06	

Arterial oxygen contents and saturation are omitted. They were within normal limits. Note that in both lower extremities of the first patient and in the right lower extremity of the second patient, the oxygen saturation has not risen above 50 per cent. Clinically these patients have just as much intermittent claudication as before the operation. In both arms and legs of Case 3, the rise is marked; clinically, the results are excellent. The same is true in Case 4 where the oxygen saturation rose very markedly. Since the table was made, the left lower extremity of the patient has also been operated upon. These few carefully checked figures indicate that sympathectomy increases the oxygenation of tissues unless diffuse vascular damage prevents a better irrigation of the tissues.

inary nature, the following suggestions have been gleaned from these determinations: (1) that venous oxygen saturation closely reflects the clinical vascular status of the patient; (2) that the rise occurring immediately after sympathectomy is maintained for several months and does not return to a preoperative level; (3) that when the oxygen saturation fails to rise after operation, as in the right leg of Case 2, the sympathectomy has not been successful. All these determinations presuppose that arterial oxygen saturation is normal, that the patient has been resting thirty minutes, fasting, and that room temperature has remained approximately the same during all determinations. While this method will not obtain wide clinical use, it gave us considerable insight into one of the benefits derived from sympathectomy.

The second important difference between the sympathectomized and nonsympathectomized limb is the comparative stability of the blood flow in a limb deprived of its vasomotor nerves. While the accumulation of metabolites regulates the nutritional needs, and while local reaction to heat and cold are maintained, extrinsic and intrinsic stimuli regulating blood pressure and temperature are ineffective in vasomotor paralysis. Normal stimuli such as cold, pain, pressure, and noise and intrinsic stimuli such as deep breathing, an altered temperature of the blood, visceral pain, and mental activity are all ineffective in diminishing the digital volume of a sympathectomized limb; whereas the normal reaction to such stimuli is vasoconstriction. I refer here to the observations of Carmichael and his associates in England and Richard Capps in this country.[1] That small subclinical stimuli can elicit an exaggerated response in a diseased vessel can be readily shown. In Figs. 4 and 5, the response of a sympathectomized and a control limb in patients suffering from anterior poliomyelitis and Raynaud's disease well illustrates the difference. In Buerger's disease, the painful afferent stimuli are again ineffective in producing vasoconstriction, and hence the vascular bed is put at rest. Rest for a diseased or inflamed blood vessel can only be of benefit. This constancy of blood flow, independent of external and internal stimuli, regulated only by metabolic needs and local temperature, is the second permanent result of sympathectomy.

Careful observations of Carl Johnson on two patients operated on by Loyal Davis for Raynaud's disease have led him to the conclusion that following a cervicothoracic sympathectomy, peripheral circulation returns to normal in less than three weeks.[10] This conclusion was based on the fact that the oscillations of the fingers, measured by a plethysmograph, returned to normal and responded to direct heat as before the operation. These observations indicate the return of an intrinsic vascular tonus after sympathetic ganglionectomy but do not reg-

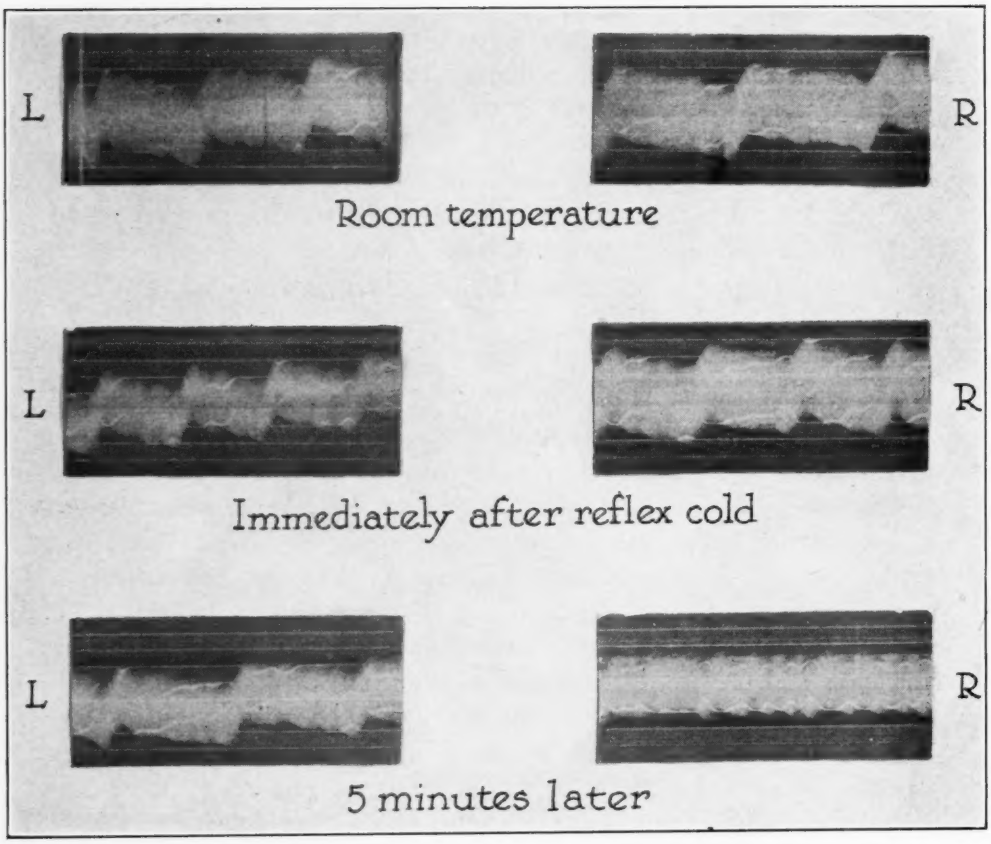

Fig. 4.—Plethysmographic records taken from right and left big toe of R. V., seventeen-year-old girl suffering from anterior poliomyelitis. The right lower extremity was paralyzed and showed vasospastic phenomena. Room temperature was 78°F. Both hands and arms were immersed in water at 50°F. This produced reflex vasoconstriction in both toes, but the vessels of the poliomyelitic extremity were much more sensitive than those of the unaffected extremity. (Courtesy of George W. Scupham.)

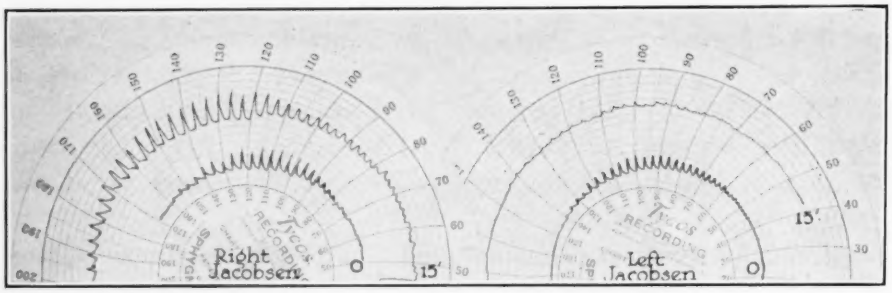

Fig. 5.—Reflex effect of cold on the right sympathectomized and left nonoperated lower extremities of A. J., forty-five-year-old patient suffering from Raynaud's disease. The two oscillometric curves at 0 are taken at the ankles after 30 minutes of rest. The right sympathectomized limb shows slightly higher spikes. After 15 minutes of cold tap water applied to the hands and arms, the nonoperated side shows a marked reflex vasoconstriction. The sympathectomized vessels could not be influenced by the efferent sympathetic impulses; they show an increased pulsation owing to the general pressure effect of cold, which raised the blood pressure in the patient from 160/100 at the ankle to 200/120. Sympathectomy was done a month before the readings; at this time when the initial full vasodilatation had long subsided.

ister the behavior of the vessels following the numerous stimuli occurring during ordinary life; nor was the operation performed a method of choice, as it produces postganglionic degeneration.

Obviously the clinical result depends on the stage of the disease in which sympathectomy is undertaken. This requires a thorough familiarity with different stages, remissions, and exacerbations of peripheral vascular disease. From the technical standpoint, the section of the thoracic sympathetic chain below the third ganglion and the section of the second and third white rami seem to result in a preganglionic sympathetic section of the upper extremity. This I have now done in fourteen instances from an anterior approach described by Gask[1] (Fig. 6). On the lower extremity, the excision of the sympathetic trunk, or trunks, between the second and fourth lumbar level produces mainly a preganglionic section in the territory of the sciatic nerve which supplies the foot almost entirely; but in the region supplied by the femoral and obturator nerves, this section is postganglionic; and truly, if one watches for the differences in temperature, a cooling of the area supplied by the saphenous nerve is often observed. The lumbar chain is approached in two stages from an anterolateral muscle-splitting incision[11] (Fig. 7). Should the patient be obese, the transverse incision of Harris[12] has been used. Transperitoneal approach has been used only if abdominal exploration was indicated.

Great conservatism is necessary to obtain good results from sympathectomy (Table IV). In the group with Raynaud's phenomena, young girls with hereditary cold fingers, patients with neurocirculatory asthenia, the hypothyroid and hypogenital types with erythrocyanosis

TABLE IV

INDICATIONS OF SYMPATHECTOMY FOR PERIPHERAL CIRCULATORY DISTURBANCES

DIAGNOSIS	TOTAL NUMBER OF PATIENTS	PATIENTS OPERATED ON	INDICATIONS
Raynaud's phenomena	25	6 (15)*	Lack of marked structural changes in the vessels; absence of sclerodactylia.
Buerger's disease	125	10 (21)	Definite collateral reserve. Absence of acute inflammation or arteriolar destruction. Poor response to conservative treatment.
Poliomyelitis	25	3 (9)	Moderate paralysis limited to one extremity; evidence of vasospastic phenomena. Age preferably between six and ten years.
Reflex dystrophy (Causalgia, traumatic vessel spasm, Sudeck's atrophy)	5	5 (8)	Severe cases, resistant to physiotherapy, exhibiting exaggerated vasomotor responses.
	180	24 (53)	

*Figures in parentheses indicate the number of patients operated on up to Sept. 1, 1936. For study of end-results, only such patients have been included who have gone through one or two winters. The recent group, however, has helped to clarify indications and technic.

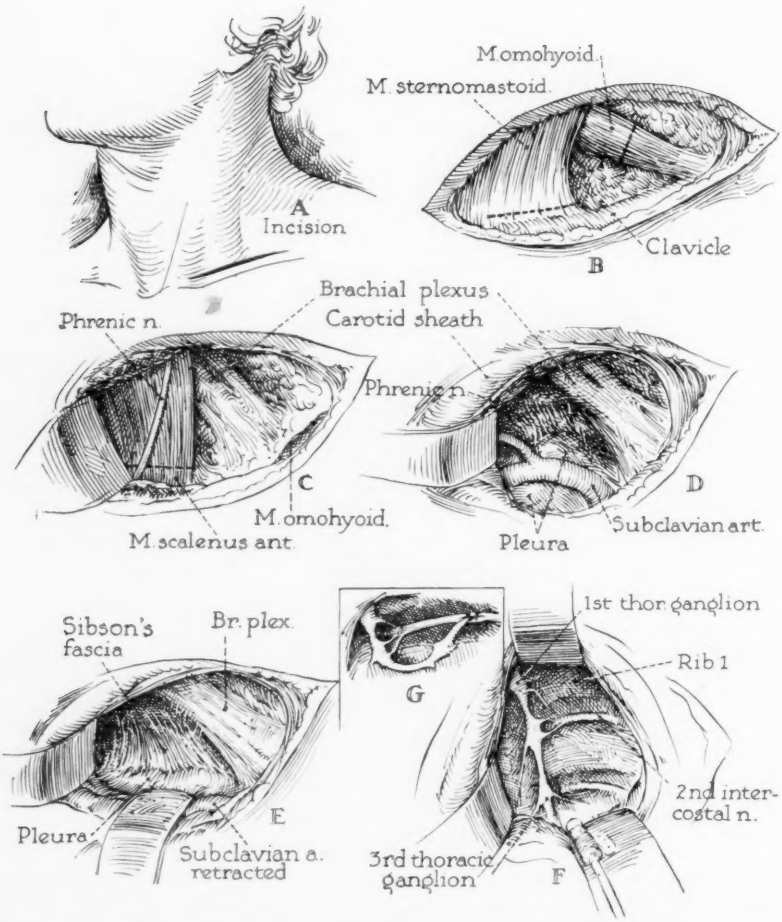

Fig. 6.—Anterior, extrapleural, preganglionic sympathectomy. Patient is operated on in a thyroid position. Premedication consists of barbiturates and morphine but no atropine unless general anesthesia is contemplated. A block of the cervical and brachial plexus is performed with 1 per cent novocaine and 3 drops of 1.1000 epinephrine to the ounce of novocaine solution. Local infiltration is done with ½ per cent solution. *A*, Skin incision is 3 inches long parallel and 2 fingers' width above the clavicle. Skin and platysma are transected in one plane. *B*, The clavicular portion of the sternocleidomastoid muscle and omohyoid are cut in the direction indicated by the interrupted lines. *C*, The loose connective tissue and fat are bluntly dissected off the scalenus anticus muscle. The transverse cervical artery and vein may present themselves and are doubly tied and cut. The phrenic nerve is visualized on the fascia of the anterior scalenus muscle, is freed and retracted medially with a nerve tape. The brachial plexus is not denuded and is as little disturbed or retracted as possible. The anterior scalenus muscle is transected after having been lifted up with a blunt, large aneurysm needle. *D*, The scalenus anticus muscle has retracted. The carotid sheath and phrenic nerve are under a medially placed retractor. The convexity of the subclavian artery is visualized. The thyrocervical axis is seen originating on its convexity. Occasionally more than one vessel is seen to originate from this site. They may have to be tied and cut so that retraction of the subclavian artery may become possible. *E*, The subclavian artery is retracted caudad, exposing Sibson's pleurocostal ligament which attaches the apical pleura to the lower border of the first rib. This fascia is sharply transected at the lower border of the first rib, thus allowing the pleura to fall back. *F*, The pleura is now gently peeled away from the costovertebral angle, as far down as to allow the visualization and transection of the thoracic sympathetic chain below the third ganglion. The exposure is greatly facilitated by the use of a lighted retractor on the pleura. The stellate ganglion is exposed just behind the origin of the vertebral artery, between it and the head of the first rib. The chain is transected below the third ganglion. *G*, The rami from the cord to the third and second ganglions are cut. The chain is thus sufficiently mobilized to permit an implantation into the second intercostal nerve so as to prevent regeneration with the proximal stump. The pleura is allowed to fall back in place. Only the sternocleidomastoid muscle is resutured. All silk technic is used with no drainage and clips for the skin. Patient usually gets up on the third day and goes home on the fifth day. Technic of Gask, modified by Telford.

have not been subjected to an operation of magnitude. Our files show a total of twenty-five patients with Raynaud's phenomena, six of whom have been operated upon. In Buerger's disease, only ten patients out of a series of one hundred and twenty-five have had sympathectomies. Out of twenty-five poliomyelitic children, we found an indication for operation in nine. In the reflex dystrophies, only the severe intractable cases, namely five, have been selected out of a large number of cases which respond well to mild physical therapy. Too loose indications and wholesale sympathectomies are just as noxious to the cause of progress as the refusal to admit the permanent improvement of circulation in well-selected cases. Recent improvements in surgical technic have also contributed to favorable results (Table V).

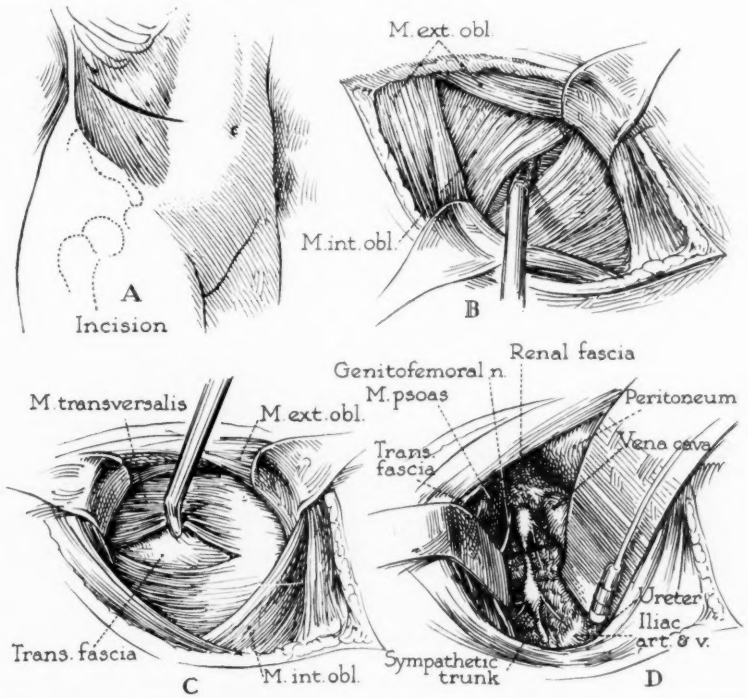

Fig. 7.—Anterolateral, muscle-splitting, extraperitoneal approach of Flothow[11] to the lumbar sympathetic ganglions. Complete muscular relaxation must be obtained by spinal or intratracheal ether anesthesia. *A*, Line of incision is transverse from midaxillary line to slightly lateral and above the umbilicus. *B*, External oblique muscle is cut parallel with its fibers and well retracted. The internal oblique muscle is now separated in direction of its fibers. *C*, When complete relaxation of the abdominal muscles is present—which may be facilitated, if necessary, by local infiltration—the transversalis muscle is split. The transversalis fascia may be split at the same level or farther laterally to protect the peritoneum which tears more easily close to the midline. *D*, The renal fascia is seen in the upper angle of the incision. This has to be well retracted cephalad to get above the second lumbar ganglion. Medially, the lighted retractor pulls the peritoneum and the vena cava, on the right, toward the midline. The iliac bifurcation should be visualized at the lower edge of the wound. A lateral retractor pulls the psoas muscle away from the vertebral column. The genitofemoral nerve is seen under the retractor. Its injury gives rise to long lasting paresthesias. The lumbar chain is removed from the level of the second vertebra to the iliac bifurcation. The distribution of the ganglia or an occasional double chain may be confusing and is subject to a great deal of individual variation. It is best to expose the fourth ganglion which is constant and to carry the dissection cephalad. The lumbar veins, if they run in front of the sympathetic chain, may have to be cut between silver clips. Closure is made in layers with all silk technic.

TABLE V

RESULTS OF SYMPATHECTOMY FOR PERIPHERAL CIRCULATORY DISTURBANCES (1928-1935)

DIAGNOSIS	NUMBER OF PATIENTS	NUMBER OF OPERATIONS	SUCCESS	IMPROVEMENT	FAILURE	MORTALITY
Raynaud's disease	6	16	7	5	4	
Buerger's disease	10	22	15	4	2	1
Poliomyelitis	3	3	3			
Reflex dystrophy	5	5	5			
Total	24	46	30	9	6	1

SUMMARY

Indications, selection of cases, and postoperative results of sympathectomy for peripheral vascular diseases have been discussed. The causes of failure have been found to be due to improper selection of cases, inadequate technic, and possible regeneration of sympathetic fibers. The improvement of the tissue anoxia, as indicated by the rise of oxygen saturation of the venous blood draining the extremity, and a constancy of blood flow uninfluenced by external or internal stimuli which reach the extremities through the vasomotor system are two persistent findings which explain the value of sympathectomy in selected cases of peripheral vascular disease.

REFERENCES

1. Scupham, George W., and de Takats, G.: Peripheral Vascular Diseases; A Review of Some of the Literature and a Critical Review of Surgical Treatment, Arch. Int. Med. **56**: 530, 1935; **58**: 531, 1936.
2. Hunt, John J.: The Raynaud's Phenomena; A Critical Review, Quart. J. Med. **5**: 399, 1936.
3. Ross, P. J.: The Recognition of Structural Changes in the Arteries in Raynaud's Disease, St. Barth. Hosp. Rep. **68**: 121, 1935.
4. De Takats, G., Hick, F. K., and Coulter, J. S.: Intermittent Venous Hyperemia in the Treatment of Peripheral Vascular Disease. In press.
5. Harris, R. I., and MacDonald, J. L.: The Effect of Lumbar Sympathectomy on Growth of Legs Paralyzed by Anterior Poliomyelitis, J. Bone & Joint Surg. **18**: 35, 1936.
6. De Takats, G.: Reflex Dystrophy of the Extremities, Arch. Surg. In press.
7. Scott, W. J. M.: Arterial Spasm in the Extremities, Ann. Surg. **102**: 331, 1935.
8. Lennox, W. G., and Gibbs, E. L.: Oxygen Saturation of Blood Draining the Brain and the Limbs of Patients With Epilepsy, Arch. Neurol. & Psychiat. **36**: 13, 1936. (See previous references to this work.)
9. Weiss, S., and Ellis, L. B.: Oxygen Utilization and Lactic Acid Production in the Extremities During Rest and Exercise, Arch. Int. Med. **55**: 665, 1935.
10. Johnson, Carl A., and Davis, Loyal: Paper presented at the meeting of Central Society for Clinical Research, Chicago, Nov. 7, 1936.
11. Flothow, P. R.: Anterior Extraperitoneal Approach to the Lumbar Sympathetic Nerves, Am. J. Surg. **29**: 23, 1935.
12. Harris, R. I.: The Rôle of Sympathectomy in the Treatment of Peripheral Vascular Disease, Brit. J. Surg. **23**: 414, 1935.

ARTERIAL REPAIR BY MUSCLE TRANSPLANTS

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THE surgical repair of injuries to large arteries and the treatment of aneurysms recalls a long list of memorable contributions. Such names as Hunter, Anel, Brasador, Wardrop, Doerfler, Murphy, and Carrel pass in review. This field of surgery always has held a dramatic interest, but the practical application of sound principles brings rich rewards. In 1902, Matas described his methods of aneurysmorrhaphy, and they soon found their way into every textbook of surgery. The restorative and reconstructive types of this operation, while they are paragons of surgical ingenuity, seldom lend themselves to the usual cases which one sees. The obliterative type is commonly used to very good advantage and is accompanied by few of the technical difficulties or dangers that are associated with the two former methods. Obliterative methods of all kinds bolster the assurance of hemostasis, but they increase the likelihood of gangrene.

Even obliterative aneurysmorrhaphy and such other procedures as proximal and distal ligation, close by or at a distance, may be followed by secondary hemorrhage. This frightful nightmare of secondary hemorrhage carries a greater threat than gangrene. With gangrene one may lose a part or most of a limb, but with secondary hemorrhage one frequently loses the patient.

If one deals with diseased vessels, as is the rule in spontaneous aneurysms, one must take into account the risk invited in attempting any reparative methods in vessel walls which already have shown their inability to withstand the pressure of the circulating blood.

Surgeons have long sought a method of repair in wounded arteries and in aneurysms which would insure hemostasis and yet preserve the arterial channel for at least time enough for collaterals to develop. The Tuffier tube and vein transplants have been used to bridge gaps in arteries made by injuries or the removal of aneurysmal segments. An occasional case succeeded, but most of them failed disastrously.

Recently we were attracted by the experimental studies in vascular surgery by Dixon[1] who demonstrated an excellent method of hemostasis and surgical repair of veins. He was especially concerned with the application of his method in the management of cases of lateral sinus thrombosis. The important part of his work centered about the

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introduction of pedicled muscle grafts into incisions in veins. He showed not only that the method brought about a rapid and secure hemostasis, but also that an essentially free recanalization of the vessel usually took place after a short interval. The remarkable recanalization he attributes to the presence inside the vein of the viable graft of muscle which acts as a scaffold to direct and support the new grown tissue. Dixon noted, but did not give a detailed report of, similar work which he conducted on the carotid arteries.

Fig. 1.—Ten days after operation; artery occluded by muscle implant graft and clot. Low power.

It seemed that since this method could be applied successfully to veins, it might serve an even more urgent rôle in arteries. Küttner and later Kirschner reported the successful use of free muscle implants into the lumens of vessels and into the sacs of aneurysms. Long before muscle implants were used, other foreign bodies, such as needles (Macewen), hair, wire (Moore), wire with galvanic current (Corradi), and mechanical contrivances (Colt), were applied. Our interest led us to attempt to reproduce the work of Dixon on arteries. We attempted to extend our investigations by producing damage to

vascular trunks with local intramural injections of escharotics. The plan was to use muscle implants in repairing wounds made at the site of these vessel weaknesses.

METHODS

We used eleven dogs in our experiments. Four arteries were used in each dog, both common carotids and both femorals. Under nembutal

Fig. 1 *A*.—High power view to show muscle fibers and recent clot closing arterial lumen. Black silk suture in arterial wall.

anesthesia, the right common carotid artery was exposed. A pedicled muscle graft from a contiguous portion of the sternomastoid was prepared. Light, nonerushing provisional occlusion of the artery distally and proximally by the sling tape method was applied. A longitudinal slit was made in the excluded segment of the artery in eight dogs, and a transverse slit was made in two. The free end of the muscle graft was pushed into the arterial incision. In five dogs, the free muscle end was directed distally in the lumen; and in five others, it was

directed cardially. The muscle implant was held in position by suture to the edges of the arterial wound with continuous sutures of fine black silk. After the implants were in place, the provisional ligatures were released.

At the same time that we implanted the pedicled muscle grafts, we attempted in other arteries of the same animal to produce arterial wall damage. We were hopeful that we might even produce some aneurysms. At the suggestion of A. C. Ivy, of Northwestern University, we injected various concentrations of silver nitrate. The use of silver nitrate was suggested because it had produced local necrosis and acute gastric ulcers in dogs when a 5 per cent solution was injected into the submucosa. We used strengths of silver nitrate varying from ¾ per cent to 2½ per cent.

A second operation on these same dogs was performed two weeks later. At this time the same procedures were applied to the right and left femoral arteries. After a period of time varying from one week to two months, the injected vessels, viz., the left carotid and left femoral, were exposed, inspected, and reinjected. In two dogs, the fibrosed areas found in the wall of the left arteries were incised and closed by a muscle graft in the same manner employed on the undamaged walls of the right arteries. One to eight months later the animals were autopsied, and the results were studied.

At the suggestion of R. H. Jaffe, of the Cook County Hospital, another method of producing arterial wall damage was tried. Each of the four large vessels was exposed, and with a sharp knife an oval area of adventitia and media was excised allowing the intima to bulge out under the intraarterial pressure. Six weeks later, the results were studied.

RESULTS

In every instance in which the pedicled muscle graft was sutured into the incised artery, twenty-four in all, the grafts took. The viable graft was found attached to the muscle at one end and to the wall of the artery at the other. The muscular fibers of the graft were paler than normal and somewhat atrophied. In four of the grafts, all on the right femoral artery, the grafts were reduced to fibrosed cords, but were still attached.

Complete and secure hemostasis was obtained in each case by the muscle graft method, but recanalization by muscular scaffold was never obtained, even after eight months. Immediately after the operation, the artery was completely or almost completely occluded by the muscular plug (Fig. 1).* Distally, however, the artery did not collapse because the rich collateral channels in the dog kept it distended by retrograde filling. The intraluminal part of the muscle graft atrophied. After one to two weeks it was gone, but as it shrunk

*We are indebted to the Department of Pathology of the Michael Reese Hospital for the preparation of the histologic sections and photomicrographs.

it was replaced by a severe obliterating proliferative endarteritis (Fig. 2). No trace of intraluminal muscle or clot was found after three months, but only an intimal cushion which completely or almost completely occluded the lumen and left only an occasional narrow limited channel along the opposite wall. The segment of artery in-

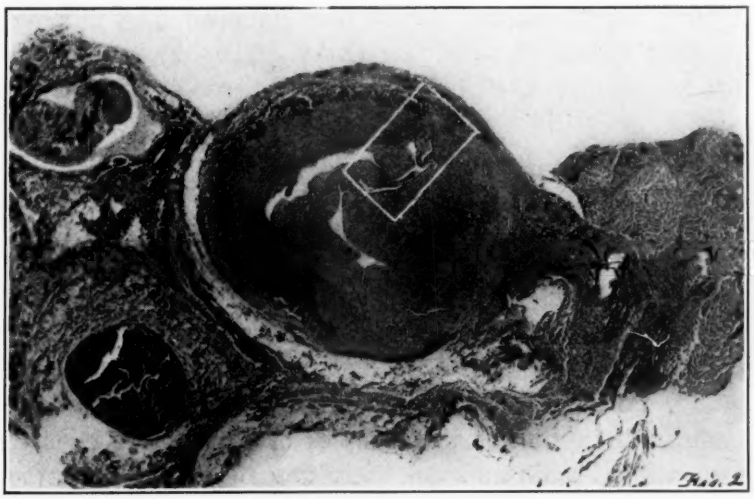

Fig. 2.—Twenty-five days after operation. Muscle graft still attached to arterial wall which is now healed. Intraluminal muscle graft and clot replaced by a proliferating endarteritis.

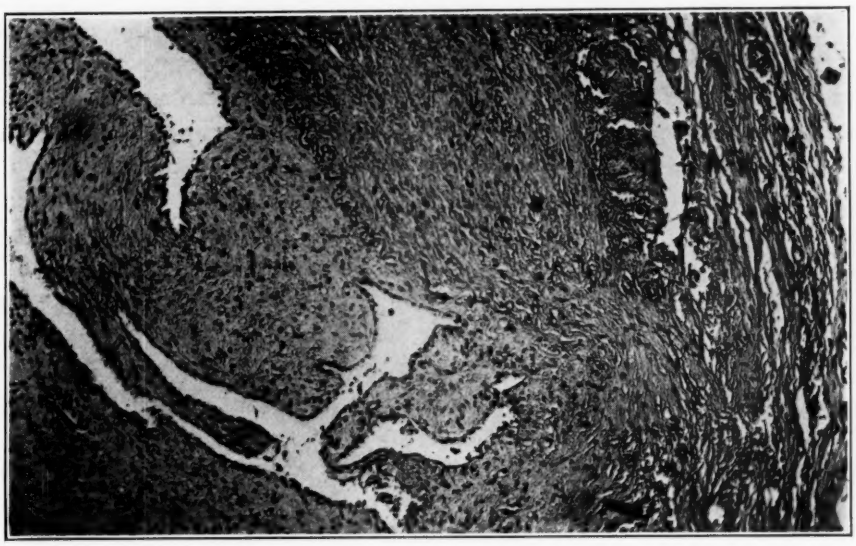

Fig. 2 *A*.—High power of proliferative endarteritis occluding arterial lumen.

volved was reduced after six months to a fibrotic cord with the muscle graft still attached to its wall. As a control experiment it was found that a simple resuture of the vessel wound without muscle implant produced only a slight endarteritis with little appreciable compromise of the lumen.

The attempts to produce arterial wall damage with consequent aneurysms were not successful. Concentrations of silver nitrate of over 2½ per cent could not be used because of the danger of acute necrosis of the wall wherever injected. This fibrosis never led to sufficient weakening of the vessel wall to produce any semblance of aneurysm. Excision of the media and adventitia resulted also finally in a replacement of these layers by firm scar tissue. The bulging intima was drawn back and buttressed by firm fibrous tissue so that aneurysms were not obtained. The response to muscle grafts which were sutured into wounds made in the silver nitrate damaged walls was identical with that seen in the undamaged arteries.

CLINICAL APPLICATION

The repair of arterial wounds is not exactly comparable with the repair of venous wounds. Repair in arteries must be accomplished against a higher pressure. The healing response is exaggerated. Obliterating, proliferative endophlebitis is rare in human pathology in comparison with the numerous examples of obliterative endarteritis. Disease of arterial wall, and especially any foreign body introduced into its lumen be it Tuffier tube, excessive suture material or muscle graft, causes enough irritation to elicit an extensive proliferative endarteritis and to insure the safety of the vessel.

This obliterative endarteritic reaction in response to the inserted muscle graft should be of considerable value in increasing the safety and efficiency of the ordinary obliterative methods when applied to diseased or infected vessels. This effect, if it can be duplicated in clinical surgery, would be of special value in insuring obliteration of those complex types of arteriovenous fistulas which occur in the neck and axillary region. The close proximity of important structures militates against clean dissection and thorough eradication of all collaterals. In these locations it would be comparatively simple to turn in neighboring pedicled muscle flaps. The muscle would act as a very favorable agent for promoting immediate coagulation because of the specific liberation of thrombokinase in large quantities. It has been used for this particular virtue in numerous surgical situations, especially in brain surgery. Where implants are made into the lumens of larger vessels, one may be assured that the earlier one secures a firm, undisturbed coagulation the better the probability of permanent obliteration.

CASE 1.—We have had occasion to use a free muscle transplant for this purpose in a subclavian aneurysm. This case presented an aneurysm of the saccular type which originated in the terminal portion of the subclavian artery and bulged from beneath the clavicle. The patient was a young healthy man who had suffered a bullet wound of this vessel some six months before. Because of the difficulty of occluding all of the collaterals which entered the sac and the intimate relation of the sac walls

with the brachial plexus, we completed the occlusion of the sac by implanting a free muscle graft taken from the pectoralis major muscle (Fig. 3). Complete hemostasis was secured, and the patient made an uneventful recovery and has retained full arm function.

CASE 2.—A colored man, twenty-eight years old, was admitted to the Cook County Hospital with a bullet wound of the left thigh. After recovery from the external hemorrhage and from wound infection, he developed a pulsatile traumatic aneurysm in Scarpa's triangle. Operation was performed a month after the injury. A large

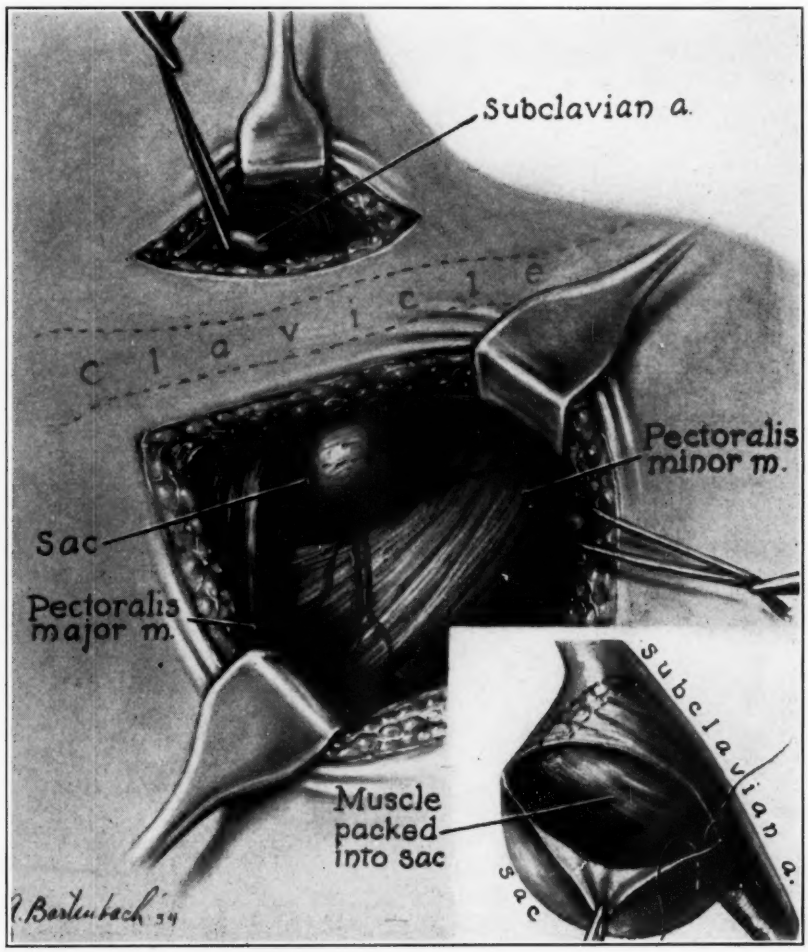

Fig. 3.—Free muscle transplant from pectoralis major packed into sac of subclavian aneurysm to secure closure of numerous collaterals without an extensive and difficult dissection under the clavicle and within the grasp of the brachial plexus. Note the proximal and distal hemostasis by the sling tape method. The sac was closed by suture over the free implant graft.

aneurysm of the left femoral artery just below the origin of the profunda femoris was found. Several collaterals opened into the sac. The adjacent tissues were indurated. After provisional hemostasis, the aneurysm was opened and emptied. In spite of proximal and distal ligation of the artery, there was still bleeding into the sac from the collaterals. A pedicled flap from the sartorius muscle was turned into the aneurysmal sac to occlude it. This resulted in completion of the hemostasis. The

patient made an uneventful recovery. There was no secondary hemorrhage despite the fact that the collateral opening into the sac was closed only by the muscle plug (Fig. 4).

The pedicled muscle graft could be used with greater freedom in questionably infected tissues than the Tuffier tube and with the same

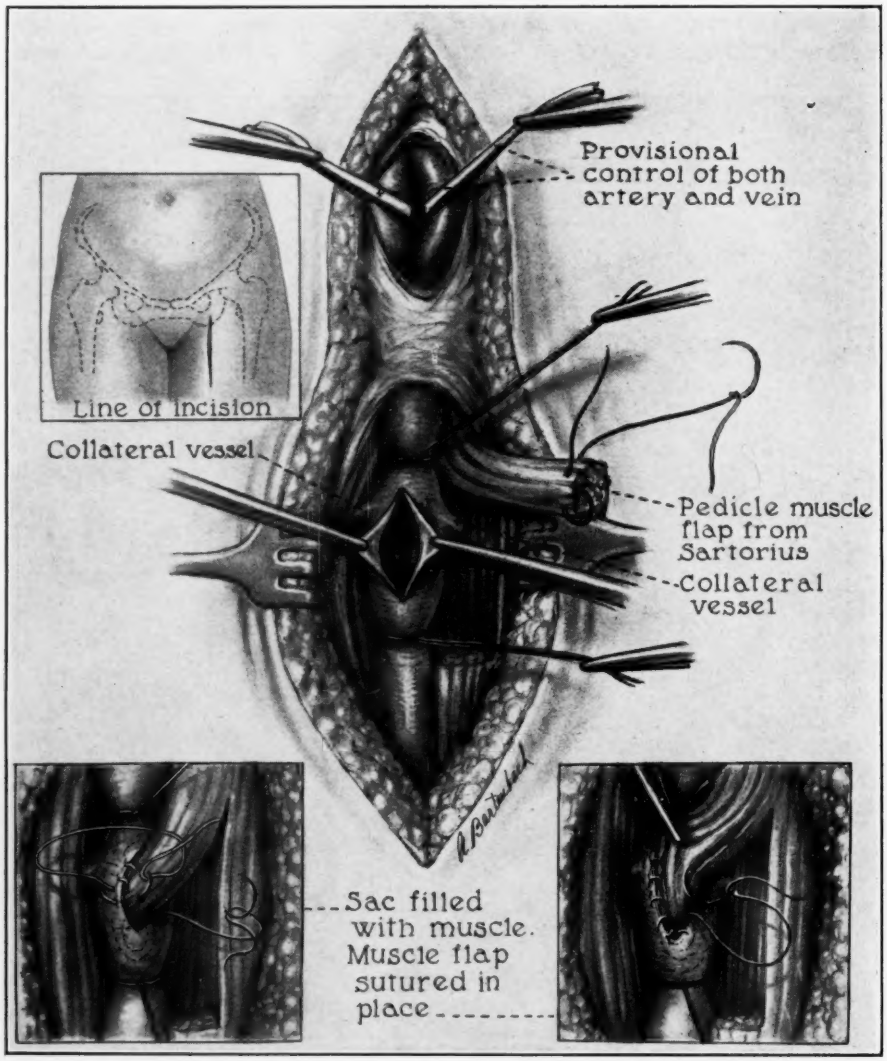
Provisional control of both artery and vein
Line of incision
Collateral vessel
Pedicle muscle flap from Sartorius
Collateral vessel
Sac filled with muscle. Muscle flap sutured in place

Fig. 4.—Pedicled muscle implant graft from the sartorius muscle into an infected traumatic aneurysm of the femoral artery. Provisional hemostasis above. Proximal and distal ligature close to the aneurysm. Collaterals closed by the graft implant, sutured into the aneurysmal opening. Primary wound healing. Good functional result.

purpose; namely, to obtain a gradual instead of a sudden arterial occlusion. The secondary operation for the tube removal would also be eliminated.

Recanalization of the arterial lumen was not obtained by us. The scaffolding effect seen in veins was not obtained by us in arteries but

was overcome by obliterative intimal proliferation. At the conclusion of this study, we found a recent report by Huard in which he describes the repair of certain surgical wounds of large arteries by

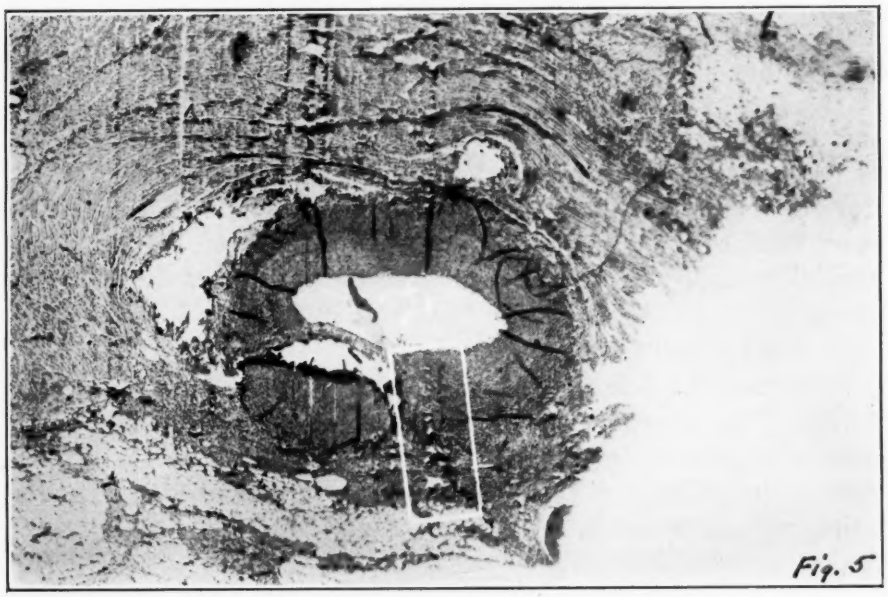

Fig. 5.—Low power view of arterial wound closed by an external muscle patch, one month after operation. Lumen completely patent. Tear in vessel wall is an artefact during microscopic section because of silk suture.

Fig. 5 *A*.—High power view to show healing of arterial wound.

rolling muscle flaps around the arteries. In the course of two periarterial sympathectomies and a hernia operation, large arteries were injured. Huard applied provisional control to the vessels; then instead of inserting the muscle into the lumen he rolled a pedicled

muscle flap around the vessel and fixed it over the defect by fine suture. Hemostasis was complete. There were no subsequent clinical or oscillometric findings of impairment of vessel lumen. This method was repeated experimentally by us in order to study the final histologic results.

Longitudinal wounds were made in the carotid and femoral arteries of two dogs. Pedicled muscle grafts were rolled around the artery and fixed to it by silk suture, so that the arterial wound was covered by the muscle patch. After two to five weeks, the results were studied. Our results completely confirmed the clinical results of Huard. In every instance there was complete hemostasis and firm healing of the arterial wound, although no sutures had been placed to unite the wound edges, and there was no immediate or ultimate impairment of the arterial lumen (Fig. 5).

The remarkable healing tendency of arterial tissues was seen in the failure of subnecrosing silver nitrate injections and even of gross excision to produce anything but a temporary injury to the arterial walls. Endarteritis did not follow these procedures because the intima was not injured.

CONCLUSIONS

In the dog, pedicled muscle insert grafts can be used to secure a reliable hemostasis in arterial wounds. They lead to an immediate, firm coagulation by virtue of the liberated thrombokinase and lead to an eventual complete obliteration of the lumen by the development of a proliferative endarteritis. The recanalization which occurs in veins after this procedure does not occur in arteries. The method is suggested as especially feasible for the permanent obliteration of complex aneurysmal sacs and their collaterals.

Two cases are reported in which a free and a pedicled muscle transplant were used for this purpose successfully.

Closure of arterial wounds by a pedicled muscle patch secures hemostasis and permits healing of the wound without histologic impairment of the lumen.

The experimental production of aneurysms by silver nitrate injections or by gross excision of the media was not successful because of the marked healing by fibrosis which occurs.

REFERENCES

1. Dixon, D. J.: Experimental Studies in Vascular Repair, J. A. M. A. **103**: 1129, 1934.
2. Huard, P.: Traitement de certaines plaies operatoires des grosses arteres par l'enroulement musculaire, Bull. Soc. méd.-chir. de l'Indochine **12**: 840, 1935.
3. McNealy, R. W.: Surgery of Aneurysms, Dean Lewis: System of Surgery, Hagerstown, Md., 1933, W. F. Prior Company, Inc.
4. Kirschner, M.: Operative Surgery, Philadelphia, 1931, J. B. Lippincott Company.

SURGICAL COMPLICATIONS DURING PREGNANCY AT THE CHICAGO LYING-IN HOSPITAL

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PREGNANCY does not preclude the occasional necessity for surgical procedures. These, if major, unquestionably increase both maternal and fetal morbidity and mortality. The internist who has studied various medical conditions in pregnant women is cognizant of the fact that pregnancy alters the anatomy and physiology of not only the abdominal organs but of the body as a whole—for example, the displacement of the diaphragm and heart, the changes in the lungs, the increased venous pressure of the veins of the legs, the increased blood volume, etc.

A brief description of the pertinent changes caused by pregnancy, as well as symptoms and signs which occur in certain diseases peculiar to pregnancy, will be given. These changes must be known by the obstetrician and the surgeon before they can properly diagnose and treat nonobstetric complications.

There is a physiologic hypertrophy of the thyroid gland during pregnancy which may be great enough to make the gland palpable. The basal metabolic rate during normal pregnancy may reach a plus 15 to 25 per cent. Approximately 10 per cent of this increase is due in some unknown way to the pregnancy per se and cannot be accounted for by fetal or maternal weight increase. The increase in basal rate is greatest in the goiter belt.

Important changes in the blood are the rapid rate of sedimentation of the erythrocytes, the slight leucocytosis, and changes in the serum electrolyte concentration. The sedimentation rate is very rapid during pregnancy and the puerperium, and therefore is of no diagnostic value as to the presence or absence of infection.

Various authors have stated that a leucocytosis occurs during pregnancy and the puerperium. Carey and Litzenberg have recently stated that the average count during pregnancy is 10,000 to 11,000, with a maximum of 13,500. Dieckmann and Wegner, using certified apparatus, determined the leucocytes in the *same* patients throughout pregnancy and the puerperium. The mean at term was 7,796, and the standard deviation was 2,685. During the first week of the puerperium,

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the mean was 8,924 and standard deviation, 3,214. At three weeks postpartum, these figures are 6,220 and 1,760 respectively. It is evident that a single leucocyte count of 10,000 to 15,000 is of little diagnostic value during pregnancy, and that the count may reach 20,000 during a normal puerperium. A rising leucocyte count, however, over a period of hours is of importance and may be indicative of infection or hemorrhage.

There is a definite decrease during pregnancy in the concentration of the serum electrolytes. Furthermore, it is more difficult to maintain the electrolyte and acid-base balance during pregnancy. Therefore, if there is any unusual loss of base and/or acid, the resultant symptoms and signs appear earlier and are more severe than in the nonpregnant woman.

Vomiting occurs so frequently in the first trimester of pregnancy that it is considered one of the presumptive signs of pregnancy. If it is of sufficient degree to cause dehydration, tachycardia, loss of weight, etc., the condition is designated hyperemesis gravidarum. Vomiting in the second trimester is rarely due to hyperemesis unless the latter condition has continued from the first trimester. Some of the non-obstetric conditions which we have seen cause vomiting during pregnancy are appendicitis, gastric or duodenal ulcer, intestinal obstruction, cholecystitis, pyelitis, tumor of the brain, food poisoning, and diabetic acidosis. Mistakes in diagnosis occur so frequently that the vomiting of pregnancy must be excluded as long as the woman is in the childbearing period. Vomiting in the third trimester should always suggest preeclampsia, but it is never the only symptom or sign of this condition. Vomiting in the puerperium should first suggest puerperal peritonitis. Other causes may be intestinal obstruction, pyelitis, etc. It is a common observation that as the uterus involutes, if adhesions from previous operations or congenital bands are present, traction may be made and thus produce a partial or complete obstruction of the bowel.

The pregnant uterus after the eighteenth week displaces the appendix and cecum upward and laterally if they are movable, and from the twenty-fourth week completely covers them. Thus, some, and occasionally all, of the symptoms and signs of acute appendicitis are distorted or absent.

During the first trimester of pregnancy, the patient occasionally has marked pain in the adnexal regions. Usually it is more marked on one side. The pain may radiate down the leg. Vomiting is occasionally present. The symptoms and signs are occasionally so marked that a diagnosis of chronic pelvic infection may be made and the patient subjected to a laparotomy. As a rule, on bimanual examination, no masses can be palpated.

Between the third and sixth months many patients complain of pain in the lower quadrants of the abdomen, which usually radiates into the labia majora. Difficulty is experienced in excluding pyelitis, ureteral stone, ovarian tumor with twisted pedicle, and appendicitis. The pain is definitely localized to the round ligament and usually disappears within a few days. There is no associated nausea or vomiting.

From May 28, 1931, to June 30, 1936, there were 13,870 deliveries in the hospital and approximately 3,200 in white women at the home. Thirty patients were subjected to major operative procedures during pregnancy, 10 during the puerperium; and 22 required additional surgery at the time of cesarean section. Minor operations were performed on eleven patients during pregnancy, on 3 during delivery, on 1 during cesarean section, and on 1 postpartum.

Table I lists the major complications which were treated during the five-year period.

TABLE I

MAJOR SURGICAL COMPLICATIONS

	SURGICAL TREATMENT OF THE COMPLICATION DURING		
	PREGNANCY	CESAREAN SECTION	PUERPERIUM (WITHIN 2 MONTHS POSTPARTUM)
Fibromyomata			
Myomectomy	6 (2 abort.)	2	
Hysterectomy	3	9	
Ovarian cyst	4 (1 hyst.)	1 (twisted pedicle and tube)	3 (1 infected)
Dermoid cyst	4		
Parovarian cyst		1 (twisted pedicle and tube)	1
Thyroidectomy	3		2
Repeat thyroidectomy	3		1
Appendectomy	3 (1 died)		2 (1 died)
Ventral hernia		5	
Carcinoma of cervix	1 (radium)	1 (radium + hysterectomy)	1 (refused treatment)
Cholelithiasis	1 (cholecystectomy)	1 (cholecystotomy)	
Exploratory laparotomy	2		
Jejunostomy			1 (died)

Fibromyomata.—Our policy is not to operate for fibromyomata during pregnancy unless their size and location would indicate that pressure symptoms might arise late in pregnancy or pain would indicate acute degeneration or pedicle torsion. In the event of the former, operation should be performed only if one is positive that the fibroid has a pedicle. In several instances, patients were operated upon with the idea of performing a myomectomy, but this was impossible, and the pregnant uterus had to be removed. If possible, the patient should be carried to term, at which time delivery can be through the natural passage. If there is an obstruction of the birth canal by the tumor,

a cesarean section, myomectomy, or hysterectomy, as deemed advisable, can be performed. Several patients required repeated hospitalization because of the severe pain and occasional attacks of nausea and vomiting. We assumed that acute degeneration in the tumors was the cause of the symptoms. Of 6 patients who were subjected to myomectomy, 2, or 33 per cent, aborted within ninety-six hours. In both of these cases, the tumor was intramural, and although the uterine cavity was not opened, there was so much manipulation of the uterus that it was probably the cause of the abortion. Mussey and Hardwick reported that 15, or 46 per cent, of the patients who underwent myomectomy either aborted or had premature labor. In a number of cases, the tumors early in pregnancy blocked the inlet, but as the pregnancy progressed, they were pulled upward, and the labor was an uneventful one. One patient with extensive tumors had the uterus rotated to such a degree that the round ligaments were inserted on the opposite side of the abdomen.

Ovarian Tumors.—Ten patients were seen with tumors of the ovary which measured 6 cm. or more in diameter. Our policy in general is, if the patient is seen in the first half of pregnancy and an ovarian tumor of the size mentioned is found, to advise its removal. In the eight patients who were operated upon during pregnancy, seven went to term. One patient was aborted and sterilized because of a subsiding acute glomerulonephritis. Two patients were found at the time of cesarean section to have ovarian cysts with twisted pedicles which also involved the fallopian tube. Both patients had lower abdominal pain, slight muscle rigidity, and a slight leucocytosis. In the case of one patient with pain in the right lower quadrant, the differential diagnosis was from pyelitis and appendicitis. No mass could be palpated, and because the patient was at term, the exploratory laparotomy with cesarean section was the procedure of choice. The other patient had pain in the left lower quadrant, and although the urine was negative, the cyst was so small that we were unable to detect it until the abdomen was opened. We again subjected the patient to exploratory laparotomy and cesarean section because of the symptoms. Three cysts were removed after delivery. The cyst was infected in one patient. A second patient had a severe thrombophlebitis after the operation. Because of the danger of infection or twisting of the pedicle, both of which seem to occur quite frequently after labor and the puerperium, we advise removal of ovarian cysts if found early in pregnancy.

Carcinoma of the Cervix.—This condition was found in two patients during pregnancy. The first patient, No. 63977, was forty-two years old; gravida, 14; para, 10; and was approximately thirty weeks

pregnant. The lesion was noted on her first visit during a routine examination of the cervix with a speculum. The pathologic diagnosis was adenocarcinoma. She was given 3,100 mg. hours of radium. Sixteen days after the radium was removed, she went into spontaneous labor and delivered a 2,000 gm. baby which seemed normal in all respects, and which has remained so to date. After delivery she was given roentgen therapy, and four years later has no evidence of recurrence.

The second patient, No. 54748, was twenty-four years old; a gravida, 2; para, 1. When she was thirty-four weeks pregnant a diagnosis of adenocarcinoma of the cervix was made. She was given 3,800 mg. hr. of radium to the cervix, and six weeks later a cesarean section and total hysterectomy with bilateral salpingo-oophorectomy were carried out. Four and one-half years later there is no sign of recurrence. A third patient was found on the routine six weeks postpartum examination to have a squamous cell carcinoma of the cervix, but she refused treatment, and all trace of her has been lost.

If a carcinoma of the cervix is diagnosed during pregnancy, it should be treated with radiation therapy. If the patient does not abort or go into premature labor, the pregnancy should be terminated when the infection of the carcinomatous tissue has subsided. If the malignancy is first noted late in pregnancy and is extensive, delivery through the vagina may cause extensive lacerations with intractable hemorrhage. Cesarean section, followed by a high subtotal hysterectomy, is the proper treatment. After delivery, roentgen ray therapy should be instituted, and when the infection has subsided, radium is used.

Exploratory Laparotomy.—Two patients were subjected to this procedure. In neither case was any ill effect noted on the pregnancy. One patient was thought to have an ectopic pregnancy, but the right adnexal mass was found to be the right kidney which lay in this region. The other patient was thought to have a chronic pelvic infection, but at the time of the laparotomy, the pelvis was found to be entirely negative.

Thyroidectomy.—As we have pointed out in a previous paragraph, the diagnosis of hyperthyroidism is not always easy to make during pregnancy. The plan which we have been following is to perform a thyroidectomy if the patient has a rather marked hyperthyroidism and is seen before twenty-four weeks. On the other hand, if she is seen in the last trimester, she is given Lugol's solution and operated upon some time after delivery. To date, we have had 50 cases of hyperthyroidism, and only 6 were operated upon before delivery and 3 after delivery. On the Washington University obstetric service, the policy has been to treat the condition medically and operate after delivery.

With both types of treatment, I have seen no increased incidence of abortion or premature labor. It is interesting to note that no thyroid crises have been precipitated by delivery. There has been one death after delivery in a patient who had hyperthyroidism and myocardial degeneration. She left the hospital under protest, delivered at home, and within an hour was dead.

Appendicitis.—The incidence of acute appendicitis ranges from 0.016 to 2 per cent. Baer, and coworkers reported an incidence of 0.17 per cent in 16,543 deliveries. Our incidence is 0.029 per cent. Statistical studies indicate that more cases occur in early pregnancy than in late and that the majority of the cases occur in the third decade. Pregnancy tends to cause exacerbations in a chronic inflamed appendix. We are not hesitant about an exploratory laparotomy during pregnancy but believe that adequate study of the patient should be made before operation. This may explain the relatively few patients who were operated on. One patient who died will be discussed in the protocols. Two patients were subjected to appendectomy during the puerperium. In one who recovered, the appendix was normal and the subsequent postoperative and postpartum course was normal. The other patient who died was admitted with general peritonitis, and the appendix was removed at the time of exploratory laparotomy.

If there is an abscess or a spreading peritonitis, the mortality is very high. There is no agreement as to the advisability of terminating the pregnancy. It is obvious that localization of the infection is impossible with either a pregnant or puerperal uterus. Therefore, because of these difficulties and dangers, it is, as a rule, better to remove an occasional normal appendix than to delay the operation too long. Because of the displacement of the appendix and difficulty of diagnosis, we advise a right rectus incision.

Gallbladder Disease.—One patient, because of nausea and vomiting, was subjected to a cholecystectomy for stones in the first trimester of pregnancy. Her vomiting, of course, was cured. It is worth noting that in a subsequent pregnancy, she also had nausea and vomiting which was cured by the usual treatment for mild hyperemesis gravidarum. The other patient entered the hospital at thirty-eight weeks with acute pain in the right upper quadrant, nausea, vomiting, jaundice, hypertension, albuminuria, and edema. It was difficult for us to exclude preeclampsia as the cause of the abdominal pain. The patient had a borderline pelvis, and although the baby was small, it was decided to perform an exploratory laparotomy, remove the baby by cesarean section, and then examine the appendix and gallbladder. One large stone was found in the gallbladder. It was removed and drainage instituted. The postoperative course was uneventful. If gallbladder surgery is necessary after thirty-four weeks, it should be

preceded by cesarean section for proper exposure. Gallbladder disease and the associated liver pathology should always be regarded with concern in pregnancy, because the pregnant woman has a predisposition to eclampsia and acute yellow atrophy. Liver function tests have been of no great diagnostic or prognostic value during pregnancy. Likewise, visualization of the gallbladder in the latter half of pregnancy is of little value.

Intestinal Obstruction.—One patient was operated upon for this condition at the thirty-seventh week of pregnancy. Adequate fluids were given pre- and postoperatively. She was delivered twenty-four hours after operation and made an uneventful recovery. As we have indicated, the differential diagnosis of intestinal obstruction during pregnancy is usually very difficult. In a period extending over fifteen years, I have seen, in addition to the case described, five other patients with intestinal obstruction. One of these occurred during pregnancy and cleared up with adequate parenteral fluid therapy and constant gastric drainage with a nasal tube. Four occurred in the puerperium; and in two cases, the condition was thought to be a neurosis, and in both instances, the patient died. The other two were operated upon after puerperal infection had been excluded as the etiologic cause of the vomiting. Tremendous amounts of parenteral fluids and electrolytes were required to regain and maintain balance.

Jejunostomy.—One patient who was admitted postpartum with a puerperal peritonitis had this operation performed. She died three hours later. Rivett, and coworkers have been advocating an exploratory laparotomy with drainage in similar cases and report a mortality of 61 per cent in patients who were treated in this manner, while the mortality was 93 to 100 per cent in those who were not operated upon. Because of the marked ileus, jejunostomy seems advisable. While we have had no experience with either exploratory laparotomy and drainage or iliostomy in the treatment of puerperal peritonitis with paralytic ileus, in view of the figures reported by these investigators, this treatment must be considered.

Genitourinary Tract.—One patient had a ureterolithotomy three weeks before term. The remainder of the pregnancy was uneventful, and the delivery was spontaneous. A second patient, when she was twelve weeks pregnant, was subjected to a left nephrectomy for hydronephrosis. Six weeks later she aborted spontaneously. The probable reason for the abortion was the nitrogen retention which developed immediately after the nephrectomy and which persisted for almost two years, ending, of course, with the patient's death. A third patient had a cesarean section for a total placenta previa. A total hysterectomy was performed by one of the junior staff. No urine was obtained by

catheter for a period of twenty-four hours, even after the intravenous injection of 500 c.c. of a 30 per cent glucose solution. Ureteral catheters were stopped 4 cm. from the bladder. The abdomen was reopened twenty-six hours after the operation and sutures cut until the urologist who was working from below could pass catheters. These were left in place and the remainder of the postoperative course was uneventful with the exception of a right ureterovaginal fistula which developed. Six months later, the right kidney was removed for a hydronephrosis. The experience of Caulk, Newell, and others has been that if both ureters are found to be blocked after a pelvic operation, a pyelotomy should be performed on one side and, if possible, on both. Thus kidney function is maintained. If the ureters were tied or cut and tied, the suture, within a period of two to three weeks, would be reabsorbed and the continuity of the ureter reestablished. During this period kidney function would be maintained until the patient's condition warranted some operative procedure to correct the condition. The procedure adopted in this case was at the suggestion of F. L. Adair who removed the ligatures and C. Huggins, the urologist, who passed the catheters. The entire procedure required considerable time and in this case was successful, but if the obstructing sutures had not been found, further surgery would have been required which would have seriously endangered the life of the patient. The safest procedure in such cases is a unilateral or bilateral pyelotomy.

Ventral Hernia.—We have had five patients with rather marked postoperative ventral hernia. The patients were delivered by cesarean section, sterilized by tubal resection or hysterectomy, and the hernia repaired. It has been our experience that hernias of the abdominal wall become much worse during pregnancy. This may be the result of the slight increase in abdominal pressure or it may be the softening of the scar tissue due to the hormonal effects of the pregnancy. Because of the large amount of tissue which is present, the hernias can, as a rule, be easily corrected, but the operation is usually unnecessarily prolonged and, in general, we believe it is not warranted because it certainly increases maternal morbidity and perhaps mortality. One patient, No. 56983, is of interest because she had a complete herniation of the uterus through an old gallbladder incision. Operation had been advised in this case, but in the interim the patient became pregnant with the result as indicated in Fig. 1. We felt that this patient, although a multipara, would have difficulty with delivery through the natural passage because of the position of the uterus and inability to keep it in the proper plane. A classical cesarean section was performed, a portion of each tube excised, and the hernia repaired. The recti and fascia had been separated to such a degree that they could not be brought together. The subcutaneous fat was scraped from the scar

tissue, and it was overlapped without resecting any portion of it. The postoperative course was stormy, but the patient recovered and to date has had no recurrence.

Operations on the Lower Genital Tract.—Eight patients were subjected to various operations, such as drainage or removal of a Bartholin gland, removal of a vaginal cyst, cervical polyp, or condyloma of the cervix. One patient had the cervix cauterized and bled so excessively that she had to be admitted to the hospital and a suture placed on the bleeding point and the vagina packed. The pregnancy was not affected. Another patient had a rupture of a varix of the vagina which was also treated by suture, pack, and blood transfusion. In general, we do not advise operations on the lower genital tract

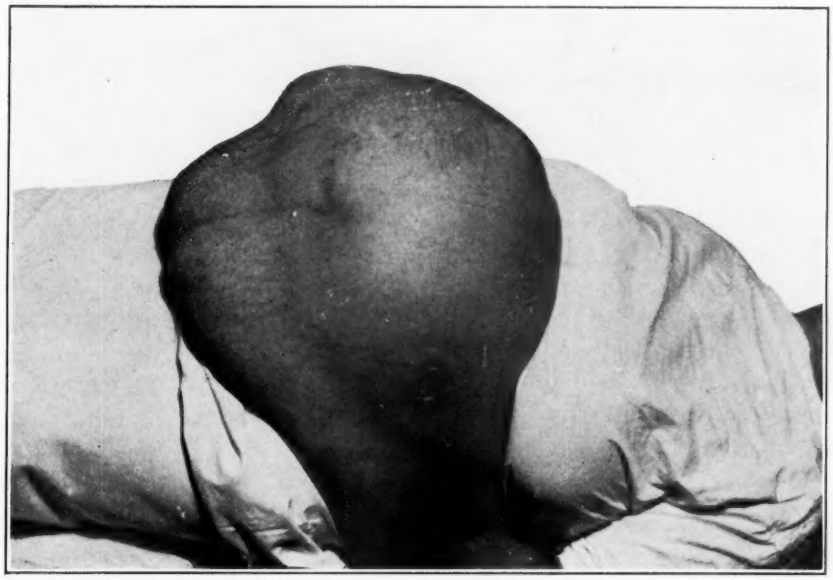

Fig. 1.—Postoperative hernia containing full-term pregnant uterus.

during pregnancy unless they are absolutely necessary. If there is an abscess in the Bartholin gland, it should be drained and the gland removed after delivery. Two patients had double vaginas, and the septum in one case was removed during labor because it obstructed the descent of the head, and in the other because the breech straddled the septum.

Miscellaneous Conditions.—There was one of each of the following conditions: ischiorectal abscess, nasal polyp, breast abscess, fibroma of breast, automobile accident, fall, and dog bite. If antitetanic or gas bacillus serum or antirabies treatment is advisable, it should be given.

Blood Transfusion.—Our reason for including this minor surgical procedure is that some physicians believe that either fetal death or premature labor may be caused by the procedure. In the five-year

period, we gave over 300 transfusions to 175 pregnant or parturient women without any ill results to mother or fetus. The average transfusion was 600 c.c., and the amount for each patient was over 900 c.c. We have given as much as 4,600 c.c. of blood within a four-week period to one patient during pregnancy without any ill effect. We believe that blood transfusion, provided proper technic is used in grouping, matching, and the method of transfusion, will have no ill effect on mother or baby.

DEATHS

Patient No. 78490 was twenty-seven years old; a gravida, 3; para, 2; and was admitted to the hospital four days after delivery with the diagnosis of a puerperal peritonitis due to hemolytic streptococcus. A jejunostomy with abdominal drainage was instituted although the patient seemed moribund. She died three hours after operation.

Patient No. 96407 was discharged from the hospital on January 17, 1934, after a normal puerperium. She was admitted on February 8, 1934, with evidence of a generalized peritonitis. An exploratory laparotomy with appendectomy and drainage was instituted on February 9, 1934, but the patient died on February 12.

Patient No. 45791, forty years old; gravida, 6; para, 5; was admitted on September 8, 1931, because of abdominal pain, nausea, vomiting, and tenderness in the right side for four days. She was approximately eighteen weeks pregnant. Her temperature was 99 degrees; pulse, 120; and respirations, 26. The leucocyte count was 14,000. There was rigidity in the right abdomen with an indefinite mass palpable in the right flank. Differential diagnosis was from a retroperitoneal abscess, twisted ovarian cyst, kidney tumor, or gallbladder disease. An exploratory laparotomy was carried out on September 10 and a large retrocecal abscess was found. It was drained both through the flank and the abdomen. The patient was discharged from the hospital well, with the exception of a draining sinus. She aborted spontaneously on October 7 and was admitted to the hospital the same day. Her postpartum course was febrile and a pelvic abscess was drained on November 11. She died on November 14. There was no autopsy. Microscopic examination of the placenta showed evidence of infection.

CONCLUSIONS

Pregnancy causes marked alterations in the anatomy and physiology of certain organs which may mask disease in them or make diagnosis difficult. A knowledge of these changes is of great importance to the physician who wishes to successfully practice the art of surgery and obstetrics.

Pregnancy, labor, and the puerperium do not contraindicate the performance of necessary operations for nonobstetric complications.

REFERENCES

Adair, F. L.: Unpublished manuscript (Textbook of Obstetrics and Gynecology).
Baer, J., Reis, R., and Arens, R.: J. A. M. A. **98**: 1359, 1932.
Carey, J., and Litzenberg, J.: Ann. Int. Med. **10**: 25, 1936.
Caulk, J., and Fischer, R.: Surg., Gynec. & Obst. **30**: 343, 1920.
Dieckmann, Wm. J., and Wegner, Carl: Unpublished data.
Dieckmann, Wm. J., and Wegner, Carl: Arch. Int. Med. **53**: 527, 1934.
Mussey, R. D., and Crane, J. F.: Arch. Surg. **15**: 729, 1927.
Mussey, R. D., and Hardwick, R.: Am. J. Obst. & Gynec. **29**: 192, 1935.
Newell, Q.: Am. J. Obst. & Gynec. **25**: 220, 1933.
Norton, J. F., and Connell, J. N.: Am. J. Surg. **32**: 325, 1936.
Priest, F. O.: Am. J. Obst. & Gynec. **31**: 878, 1936.
Rivett, L., Williams, L., Colebrook, L., and Fry, R.: Proc. Roy. Soc. Med. **26**: 45, 1933.
Royston, G. D., and Fisher, A. O.: Am. J. Obst. & Gynec. **11**: 184, 1926.
Shallenberger, W. F.: Am. J. Surg. **28**: 582, 1935.

THE TREATMENT OF CARCINOMA OF THE CERVIX BY THE COMBINED USE OF RELATIVELY SMALL AMOUNTS OF RADIUM AND DEEP X-RAY*

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CARCINOMA of the cervix has been conceded to be a radiotherapeutic problem by the leading gynecologists for fifteen or twenty years. Unfortunately, the number of clinics with trained radiologists is limited, and only a small percentage of the total number of malignant cases in this country are seen in these clinics. The majority are either untreated or treated in the general hospital. Surgical treatment is still too often used in the general hospitals, either alone or in conjunction with radiation therapy. This undesirable method is applicable only to those cases in which the disease is limited to the cervix. It persists because there is either no available radium or the results with radiation alone have been unsatisfactory on account of an inadequate dose or other causes.

There are generally speaking two acceptable methods of treating cancer of the cervix with radium, namely: (1) with a large amount of radium for a short period of time, and (2) with a small amount of radium over a long period of time. The latter method is advocated by the French school headed by Regaud, whereas in this country, the leading clinics employ the former. Both schools, however, supplement the radium with deep x-ray therapy. Only a very few hospitals can afford enough radium to employ the former method. A large number of the smaller hospitals own from 50 to 100 mg. of radium for the treatment of menstrual disorders, which, if divided into the proper cells or needles, can be used effectively in the treatment of cervical cancer by the latter method. The few papers published dealing with the technic of treatment of cancer of the cervix are either not detailed enough to be of value to the profession in general, or require more radium than is available in the smaller clinic. So few cases are treated in the individual general hospital that the investment in a large amount of radium is not profitable. There seems to be, therefore, a pertinent need for a detailed description of the technic of treating carcinoma of the cervix with relatively small amounts of radium.

It is not necessary to discuss at length the physics of radiation in a paper dealing with the technic of treatment. Certain general prin-

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ciples, however, must be considered for the purpose of clarity in the discussions that follow. The intensity of radiation at a series of points varies inversely as the square of the distance of the points from the source of radiation. If the intensity of radiation received by numerous points surrounding a fixed source of radiant energy is measured and all points receiving an equal dose are connected by a line, a curve is formed. Such a curve is known as an isodose curve. In case the source is a point, the isodose curve forms a circle; whereas, if the source is a tube, the curve is in the form of an ellipse (Fig. 1), representing the summation of innumerable point sources situated in a straight line. The intensity of the radiation diminishes toward the end of a tube as compared to the center. These facts must be known in order to provide doses of known intensity at desired points when multiple tube sources of radium are employed.

To obtain a good ultimate result in the treatment of any malignancy, it is necessary that an adequate total dose be received by the entire

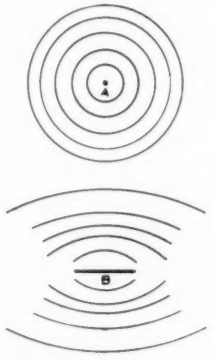

Fig. 1.—Diagrammatic sketch of isodose curves radiated from a point source, *A*, and a radium tube, *B*. Around the point source the curves form a circle; around the tube, an ellipse.

lesion with minimal destruction of normal tissue. Since the dose to a given point decreases with an increase in the distance of the point from the source, a necrosing dose may be given to the normal tissues lying between the source of radiation and the tumor. To minimize the danger of normal tissue damage, multiple sources, designated as portals, have been used in both x-ray and radium therapy. An attempt is made to direct the beams from the various portals toward the lesion. The dose to the lesion by such a focusing of rays is increased, whereas the normal tissue between each portal and the lesion receives only a fraction of the total effective dose. This principle is employed in all present-day methods of radium treatment for this condition.

Rays emanated from the high voltage x-ray and from radium vary in wave lengths. The longer the wave length, the less penetrating is the ray. Lack of penetration implies increased absorption, with consequently increased danger of destruction to intervening normal tissue.

Filters are used to remove the long or so-called soft radiations. Failla[1] has shown that for practical purposes in radium therapy a filter of 2 mm. of brass or its equivalent is sufficient, since relatively homogeneous rays are obtained when these filters are used. It must be remembered that any increase in the thickness of the filter increases the distance of the radium from the lesion, and when tubes are used, the measured length of the tube is increased due to the increased filter material over the ends. When radium rays or x-rays come in contact with metal or tissue, secondary radiations of longer wave lengths are produced. In the treatment of malignancies with radium, an additional filtration of at least 2 mm. of rubber is added to remove the soft rays emanating from the metal filter, thus minimizing the necrosis of the tissues immediately surrounding the source.

Numerous methods have been employed in calculating the dose delivered to a given point at different distances. In measuring the roentgen ray, the usual method employed is the "water phantom." The actual penetration is measured in R units which pass through various depths of water. With radium as the source, actual measurements have also been made of the radiation received at the periphery of a sphere when the radium is planted in the center of the sphere. Both animal tissues and materials such as butter, wax, etc., have been used for this purpose. Given these measurements and the relationship of tube radiation to point source radiation determined by Quimby,[2] it is possible to calculate in skin erythema doses the total dose of radium energy which is delivered to a given point from single or multiple portals employing tube sources. Quimby[2] has carried out such calculations, which have been used in this paper as a check on corresponding estimations.

Carcinoma of the cervix falls in the group of tumors classed as radiosensitive; i.e., the malignant cells are more sensitive to the roentgen and radium rays than the cells of normal tissue. Therefore, it is theoretically possible to destroy the neoplastic cells without destruction of the normal tissues.

There are two ways of directly attacking malignant tissue with radium, namely, selective and caustic. In the former, advantage is taken of the above difference in sensitivity; i.e., a dose is sought sufficient to destroy the neoplasm without destruction of the normal tissues. In the latter, a dose sufficient to destroy not only the tumor but the intervening and surrounding normal tissues is given. This result does not differ from that obtained by electrocoagulation or the actual cautery, resulting in large radiation sloughs with the danger of subsequent infection. Obviously the caustic method is not applicable to the treatment of carcinoma of the cervix due to the proximity of the bladder, ureter, and rectum to the involved area. In practice

it is impossible to distribute radium so that a selective dose is given throughout the entire treated area. If an adequate dose is given, there is always, therefore, a slight necrosis of normal tissue.

Neoplastic cells that are sensitive to radium rays become more resistant to these rays following sublethal exposure; this resistance increases with each such treatment. On the contrary, however, the normal cells become less resistant with each exposure, so that the sensitivities of the two approach each other. Thus, it is important that an adequate dose be given at the first treatment, since with repeated sublethal exposures selective radiation becomes impossible; and in order to eradicate the disease, a caustic dose becomes necessary. In addition, a dose that primarily would have been a selective dose may, after previous radiation, be a caustic one due to the increased sensitivity of the nonmalignant cells; and subsequent radiation of any type may prove dangerous.

It would be desirable to know accurately the effective dose for destruction of both cancer cells and normal cells so as to be able to build up proper selective doses in practice. The actual effect of gamma and x-rays on cells is not known. Why one cell is sensitive and another resistant is an unsolved question. For this reason radiotherapy is not an exact science, and the methods, dosage, etc., are empirical. Normal cells react differently to the same total dose if delivered during a short interval of time as compared to a long interval. The difference is that these cells seem to undergo less change if the exposure is protracted. For this reason it is difficult to state what the actual necrosing dose is. Squamous carcinoma will respond to a dose of from 6-10 S.E.D. (skin erythema dose), according to the grade of the malignancy.

The application of the underlying principles to actual therapy is conditioned, of course, by the clinical problem. Carcinoma of the cervix may be of two types, namely, squamous and adenocarcinoma. The former is the most frequent and usually begins at the transition zone; i.e., where the squamous epithelium of the vaginal portion joins the columnar epithelium of the cervix. Although Hurdon[3] regards the internal os as the natural boundary to the extension of carcinoma of the cervix, Schottlander[4] found in 120 specimens of cervical cancer examined, definite invasion of the uterine wall. The lymphatics of the cervix drain into the pelvic lymph glands. The lower group of glands is most often affected; that is, the parametric, iliac, hypogastric, and sacral. Patients suffering from carcinoma of the cervix rarely present themselves for treatment while the disease is limited to the cervix, although the lesion may be classified clinically as operable. The regional lymph glands were found to be involved in operable cases, according to Sampson,[5] in 30 to 50 per cent; to Schottlander,[6] in 47.8 per cent; and to Martzloff,[7] in 57.6 per cent. The importance of these

observations is at once apparent. If a high per cent of cures is to be obtained in every case of carcinoma of the cervix, each of the drainage areas must receive a lethal dose, even if clinically from examination of the cervix the disease may not appear extensive.

In this country, the leading radiologic clinics use a large amount of radium for a short period of time. Burnam usually employs 1 to 3 gm. of radium, giving 4,500 mg. hr., 3,000 of which are applied intracervically and 1,500 to the vaginal portion of the cervix and vaginal vault by a Vickers plaque. This is supplemented by deep x-ray therapy of the Coutard type employing 200 kilovolts. A total dose of 1,500 to 2,400 R is given through each of four portals, two anterior and two posterior, directed toward the parametria. This is the type of x-ray

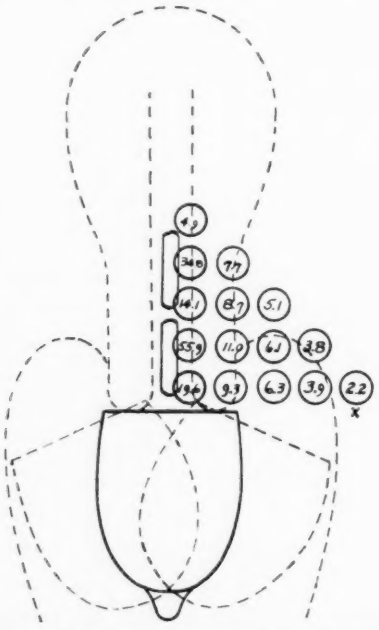

Fig. 2.—Diagrammatic sketch of Healy's method of treating carcinoma of the cervix. This diagram is identical with Healy's original[8] with the exception of a normal uterus drawn to scale for purpose of comparison. The numbers in the circles represent the erythema dose as calculated by Quimby. A total of 6,000 mg. hr. is given: 3,000 by the cervical tandem, 1,000 by the upper tube, and 2,000 by the lower; the remaining 3,000 by the radium bomb, 1,000 in each position as shown above, i.e., to the cervix and each fornix. In addition to this, the patient receives a full course of deep x-ray. This illustrates the use of five radium portals to increase the dose to the tumor-bearing area. (The point *X* measures 4.5 cm. from the center of the cervical canal.)

therapy almost universally employed at the present time. Healy[8] with 0.4 to 1 gm. of radium, usually gives a total of 6,000 mg. hr., 3,000 intracervical and 1,000 by a radium bomb placed in the vaginal canal in each of three positions, i.e., in each fornix and against the cervix (Fig. 2). This is supplemented by deep x-ray therapy as above.

The advantage of the methods using large amounts of radium is the short period of hospitalization which permits a larger number of cases to be treated in a given period of time. The disadvantage is that the

amount of radium required represents an investment of from $75,000 to $100,000. These methods are therefore not applicable to the general hospital.

The method usually employed in the general hospital (Fig. 3) consists of a simple intracervical application of 0.05 to 0.1 gm. of radium for a total dosage of from 2,000 to 3,000 mg. hr. The time varies with the amount of radium available and is rarely less than 30 hours. This may or may not be supplemented by deep x-ray therapy, the dosage of which rarely approaches that given by the Coutard method. An effective dose is given only opposite the center of the tubes and does not extend beyond the limits of the cervix. The remainder of the tumor-bearing area receives a sublethal dose. (Fig. 4.) This treatment is not adequate in a curable case and should only be employed

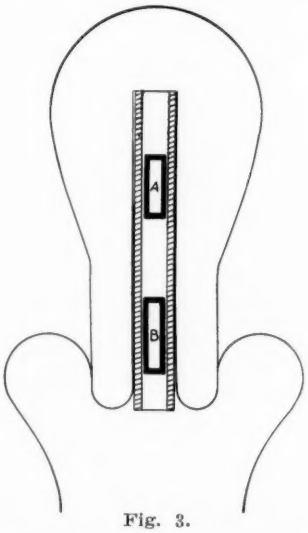

Fig. 3.

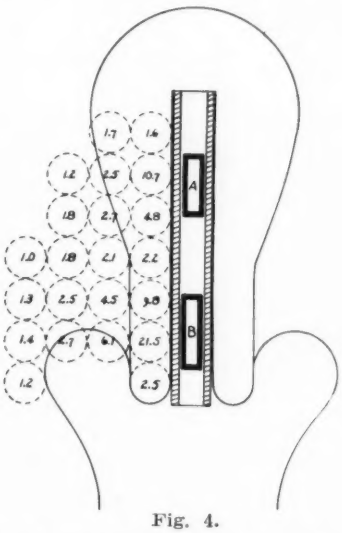

Fig. 4.

Fig. 3.—Diagrammatic sketch of the method of treating cancer of the cervix usually employed in the general hospital, i.e., by the simple cervical tandem. *A*, is a radium capsule containing 25 mg. of radium and *B*, a radium capsule containing 50 mg. of radium. The capsules are of platinum and are 1 mm. in thickness. An additional filtration of 2 mm. of rubber is represented by the crosshatching.

Fig. 4.—Diagrammatic sketch of the simple cervical tandem showing the erythema dose received by the surrounding tissue. These doses were calculated from a total dose of 3,000 mg. hours. It is obvious that the tumor-bearing area receives an inadequate dose. This illustrates the difference in the radiation from the end as compared to the middle of the tube.

for palliation, if at all. The disadvantage is that of a sublethal exposure with change in the radiosensitivity of the cells as previously discussed.

Regaud developed the treatment of carcinoma of the cervix by the use of equally small amounts of radium over a long period of time (Figs. 5 and 6). The treatment is based on the attractive theory that by using the radium over a long period of time more of the neoplastic cells are exposed to the rays during mitosis, a period of theoretically increased sensitivity. The total dose rarely exceeds 8,000 mg. hr. The

amount of radium varies from 50 to 60 mg. and is left in place for from five to seven days. The radium treatment is also supplemented by deep x-ray therapy. The advantage of this method is the small amount of radium required which at the present price has a value of approximately $4,000. Compared to the usual method with small amounts of radium, the outstanding advantage of Regaud's method is its effectiveness. The disadvantage is the discomfort caused the patient by the prolonged treatment and the cost of the long hospitalization period.

In this paper, diagrammatic sketches of a normal uterus, showing the arrangement of the radium tubes and the filters used, have been drawn to scale for comparison of (1) Healy's method, (2) the simple

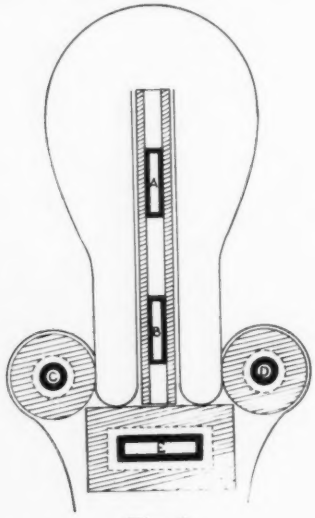

Fig. 5.

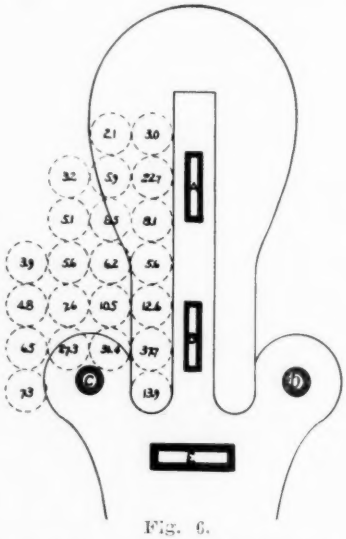

Fig. 6.

Fig. 5.—Diagrammatic sketch of Regaud's method of treating carcinoma of the cervix, *A*, *B*, *C*, and *D* represent radium capsules each containing 13.3 mg. of radium. *E* is a radium capsule containing 6.6 mg. of radium. The total amount of radium employed is 59.8 mg. The radium in these capsules is filtered by 1 mm. of platinum and 1.25 mm. of brass. The crosshatching represents rubber filters; that surrounding *A* and *B* measures 2 mm.; and that surrounding *C*, *D*, and *E*, 5 mm. *C* and *D* are held in a colpostat (the connecting metal limb is not shown). *E* is contained in a free rubber capsule.

The uterine cavity is measured under anesthesia and the radium placed accordingly, so that *A* lies within the internal os and *B* in the middle of the cervical canal. The colpostat is placed so that it fits snugly into the vaginal fornices. *E* is placed against the cervix and held there either by the vaginal packing or by a silk suture. The vaginal canal is packed with gauze to keep the bladder and rectum from coming in contact with the radium. A self-retaining catheter is placed in the bladder in preference to repeated catheterizations as there is less danger of infection. The radium is left in place for five to seven days. The treatment may be interrupted if necessary or the vaginal packing changed. X-ray therapy is begun from seven to ten days prior to the insertion of the radium. The patient is given 200 R through each of two portals daily, during which time she receives douches. This preliminary roentgen radiation is frequently followed by a shrinkage of the tumor and a clearing of the infection as shown by the disappearance of a low-grade fever. Following insertion of the radium, douches are discontinued, but the x-ray therapy is continued until a total of 1,500 to 2,400 R have been delivered through each port, the total depending on the condition of the patient.

Fig. 6.—Diagrammatic sketch of Regaud's method of treating carcinoma of the cervix, showing the erythema dose received by various areas. These doses were calculated from a total dose of 8,000 mg. hr. The rubber filters have been omitted for clarity. This diagram again illustrates the use of multiple portals. A high total dose is given to the tumor-bearing area. With this high concentration in the broad ligaments from radium alone, a lethal dose can be given to the tumor-bearing area with less x-ray than required after the simple cervical tandem (Fig. 4).

cervical tandem, and (3) Regaud's method. Using Quimby's tables of radiation from a tube source as compared to a point source, and the distances of the various areas from the portals as measured on the accompanying scale figures, together with the given dosage at the sources, the erythema doses received by various areas of the cervix, vaginal vault, and broad ligaments have been calculated. These calculations were checked by recalculating the doses obtained by Quimby as reported by Healy[8] (Fig. 2). The result of this check showed the results of Quimby's calculations to average only 5 per cent more than those obtained by the method here employed. This is well within the limit of error and serves as a satisfactory control of this method of calculation.

The results of this calculation (Figs. 4 and 6) reveal that, in general, Regaud's method delivers a relatively satisfactory dose of radiation to the important routes of spread as well as to the usual site of the tumor, comparable (Table I) to that delivered by Healy's method

TABLE I

SHOWS SKIN ERYTHEMA DOSE RECEIVED BY CORRESPONDING REGIONS OF THE TUMOR-BEARING AREA WHEN TREATED BY THREE METHODS*

	REGAUD	HEALY	SIMPLE CERVICAL TANDEM
Vaginal portion of the cervix	13.9	19.6	2.5
Nearest line of spread	37.7	55.9	21.5
Nearest parametrium	31.4	11.0	6.1
Most distant parametrium	7.3	2.2	1.2

*Compare Table I with diagrams 2, 4, and 6 for source of figures and for comparison of other areas.

(Fig. 2) requiring large quantities of radium. The radiation delivered by the usual application of small amounts of radium is so far below the estimated lethal dose for the cancer cell in important areas of spread (Fig. 4) that it is doubtful that supplementary x-ray treatment can be given safely in sufficient dosage to destroy malignant cells. Comparison of the three methods as to cost and time (Table II) reveals the relative advantage and disadvantages of each.

TABLE II

COMPARISON OF THE THREE METHODS WITH RESPECT TO AMOUNT OF RADIUM NECESSARY, TOTAL COST OF RADIUM, TOTAL DOSE, AND TIME REQUIRED

	REGAUD	HEALY	SIMPLE CERVICAL TANDEM
Amount of radium	50-60 mg.	400-1,000 mg.	50-100 mg.
Cost of radium	$3,750-$4,500	$30,000-$75,000	$3,750-$7,500
Total dose	8,000-9,000 mg. hr.	6,000 mg. hr.	2,000-3,000 mg. hr.
Time required	5-7 days	6-15 hours	30-60 hours

The choice of methods of treatment depends ultimately on the clinical results as judged by five years' cures. Numerous statistical reports

on the results of radiotherapy in the treatment of cervical malignancies are made by the clinics using large quantities of radium. Crossen[9] has analyzed these reports and finds that there is no essential quantitative difference between the results obtained in this country and those of Regaud when the lesions are grouped into classes, although Regaud's method appears to be superior when the cases are not so analyzed. Certainly Crossen's study permits the conclusion that Regaud's method is not inferior in effectiveness to methods employing larger amounts of radium.

This method of treating cancer of the cervix is not without danger and must be regarded as a potentially lethal procedure. Lacassagne[10] states that the method carries a primary mortality rate of 2 per cent and that death is usually the result of streptococcus infection. Patients with an elevated temperature should be treated cautiously, and all pelvic infection eliminated if possible before the insertion of the radium. Not infrequently a low-grade fever disappears after a few days of vaginal douches and x-ray therapy. Anemic patients must be actively treated with frequent blood transfusions and radiation therapy delayed until the general condition has improved. A marked drop in the total white blood cells is a danger signal and should be regarded as a sign for at least temporary cessation of the treatment.

The end-results are theoretically not altered by frequent rest periods as long as the total time does not exceed thirty days. Toward the end of the treatment, a majority of the patients develop a proctitis. If this is severe, it is safer to stop the treatment entirely.

CONCLUSION

The underlying principles of radiation therapy of carcinoma of the cervix have been discussed. The erythema dose received by the cervix, vaginal vault, and broad ligaments has been calculated and illustrated by diagrams when treated by: (1) Healy's method, (2) the intracervical tandem, and (3) Regaud's method. The second cannot be judged on published reports, since the number of cases treated in the individual hospitals is too small to report. An attempt has been made to show by diagram that an adequate dose is not delivered by this method.

Regaud's method has been shown to be applicable to the general hospital and is known from clinical results to be relatively satisfactory. The technique of this method has been described.

REFERENCES

1. Failla, G.: Filtration in Radium Therapy, Radiol. Rev. & Chicago M. Rec. **52**: 133-139, 1930.
2. Quimby, E. H.: The Grouping of Radium Tubes in Packs or Plaques to Produce the Desired Distribution of Radiation, Am. J. Roentgenol. **27**: 18, 1932.

3. Hurdon: Quoted from Graves' Gynecology, Fourth Edition, Philadelphia, W. B. Saunders Company, p. 391.
4. Schottlander: Quoted from Graves' Gynecology, ed. 4, Philadelphia, W. B. Saunders and Company, p. 391.
5. Sampson: Quoted from Graves' Gynecology, ed. 4, Philadelphia, W. B. Saunders and Company, p. 394.
6. Schottlander: Quoted from Graves' Gynecology, ed. 4, Philadelphia, W. B. Saunders and Company, p. 394.
7. Martzloff: Quoted from Graves' Gynecology, ed. 4, Philadelphia, W. B. Saunders
8. Healy, W. P.: Carcinoma of the Cervix, Radiology **14**: 217, 1930.
and Company, p. 394.
9. Crossen, H. S.: Radium Methods and Statistics of Cancer of the Cervix, Am. J. Obst. & Gynec. **28**: 378, 1934.
10. Lacassagne, A.: Results of the Treatment of Cancer of the Cervix Uteri, Brit. M. J. **2**: 912, 1932.

THE SURGICAL CORRECTION OF MANDIBULAR PROTRACTION, RETRACTION, AND FRACTURES OF THE ASCENDING RAMI*

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CORRECTIVE surgery of the jaw concerns itself with the same problems that are associated with pathologic changes in skeletal structures elsewhere in the body, excepting those of weight-bearing and the transposition of tendons. Two separate considerations are peculiar to this bone; namely, the pronounced cosmetic influence of deformity, and the dental changes incident to deformity, disease, and trauma.

In function, too, the mandible is peculiar in that it has a double articular and muscular mechanism, identical on the two sides. This identity must remain intact to permit proper function (Fig. 1). The arc or fused ramus of the mandible is the only means of preserving symmetry or balanced motion at these joints. Motions permitted by the temporomandibular articulations are more varied in character and greater in number than those of any other joint in the body, when the mandible functions as a symmetrical unit. On the other hand, a disturbance of anatomic symmetry greatly reduces the character and range of motion of the mandible and results in dental malocclusion and either immediate or late progressive disturbance in one or both temporomandibular joints (Fig. 2).

The mandible is motivated by a double set of identical muscles which are complementary and synergistic only when the lower jaw functions as an anatomically correct unit. Both functions of muscle—the maintenance of balance and stability, and the actual production of motion—are always conditioned by an entirely quantitative, balanced action of both groups because of their identity on the two sides. There are no groups of overlapping muscular function comparable to those found in the extremities, so that the performance of motion and stability by accessory groups is impossible. Traumatic or surgical conditions that alter the anatomic symmetry of the vertical rami in any gross degree will change the angle of applied muscular force on the injured side. For example, in its relationship to the jaw as a whole, an external rotation of the ascending ramus of one side—because of fracture or osteotomy—will result in difficulty of temporomandibular function by reason of anatomic alteration of the condylar articular surface (Fig. 3).

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This difficulty will be aggravated, in opening movements of the jaws, by the artificially created, increased, median component of forward pull exerted by the external pterygoid muscle of that side. Thus, in contraction, this muscle will pull the rotated condylar head obliquely over the temporal eminence. Because of capsular laxity and the generous range and character of the motion of the temporomandibular joint, such difficulty on one side is always absorbed in part by the joint of the sound side or is divided between the two joints as soon as mandibular continuity is

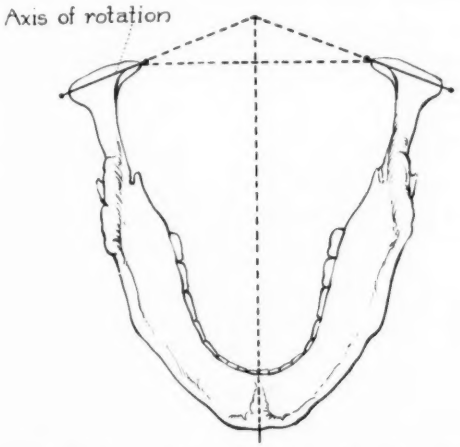

Fig. 1.—The axis of rotation of each condylar head determines an angle of approximately 12 degrees with the frontal plane and 24 degrees with the contralateral side.

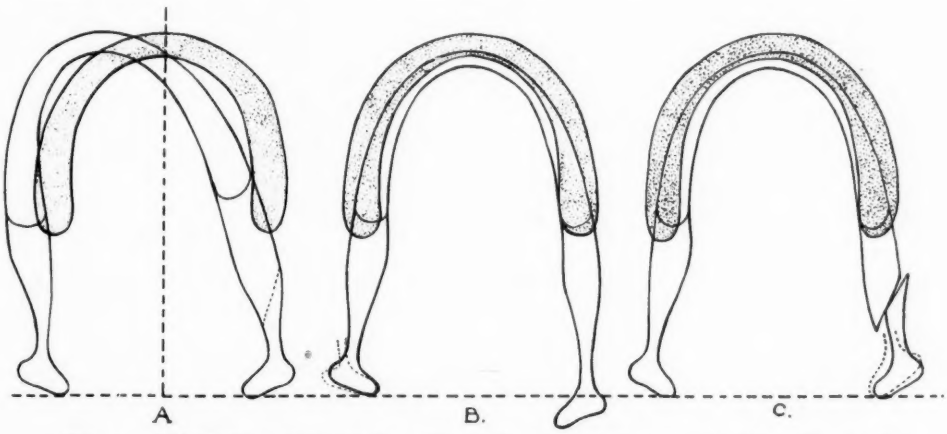

Fig. 2.—Schematic representation illustrating the influence of deformity at the temporomandibular articulations, *A*, and the necessity of restoring anatomic symmetry, *B* and *C*.

reestablished. Frequently, the most severe clinical symptoms arise from secondary or associated difficulty in the joint on the sound side. These dynamic considerations, discussed in an earlier report,[12] are outlined here to emphasize the particular responsibility for maintaining or restoring anatomic balance or symmetry in corrective work of this region.

It may be said, therefore, that surgery of the mandible should fulfill these individual physiologic and cosmetic requirements, and treatment in each case should achieve these three results: (1) esthetic facial appearance, (2) correct dental articulation, and (3) proper function of the mandible as a whole.

Among the more serious mandibular conditions that require surgical care, those concerned with overdevelopment and underdevelopment of the jaw, together with allied lateral deviations, have formed a difficult and uncertain field of surgical effort. Numerous operations devised to correct the conspicuous deformities of prognathism and micrognathism have been employed during the past thirty-eight years (Fig. 4) with more or less success.

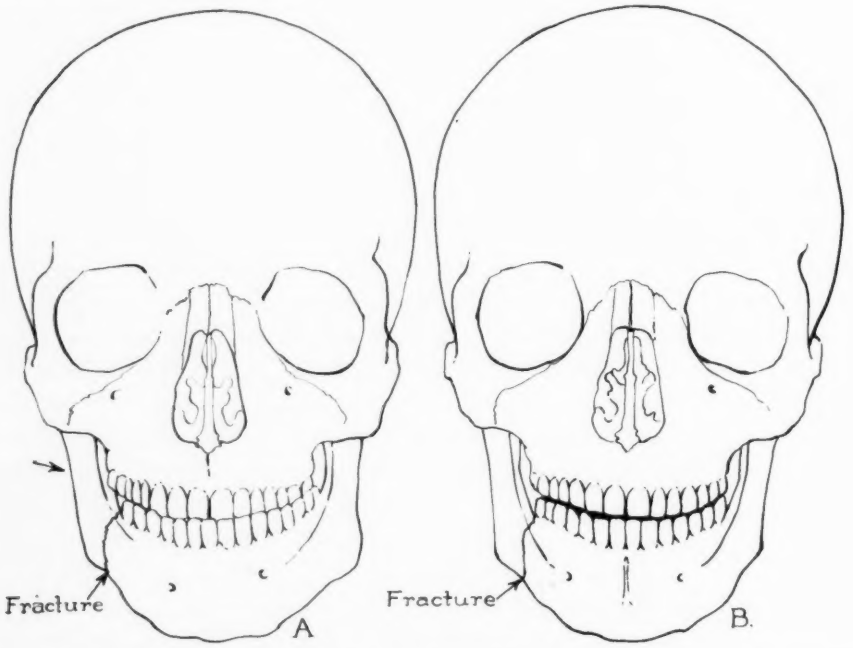

Fig. 3.—Case S. A. *A*, External rotation right ascending ramus with deviation of jaw to left (laterognathism); malocclusion and marked bilateral temporomandibular joint disturbance. *B*, After operative correction.

It is, therefore, the primary purpose of this presentation to describe an operative procedure devised and practiced for the relief of mandibular protraction and retraction. In addition, a supplementary operation to complete correction of difficult or extreme micrognathism will be described. A final purpose is that of advocating the use of the same surgical approach for the correction of certain displaced and irreducible fractures of the ascending rami.

The entire management of these deformities consists of three parts: (1) orthodontic treatment, (2) surgical and orthopedic treatment, and (3) prosthetic treatment.

Orthodontia aims to secure functional and cosmetic conformity of the upper and lower dental arches. Surgery should effect a radical change in the position of the mandible and the contour of the lower part of the face. The orthopedic aspect of treatment concerns itself with the fixation of fragments or an improvement in their position. Prosthetic treatment remedies the defects which have not been corrected by the preceding manipulations. In cases of conspicuous mandibular protraction or retraction, correction is impossible by orthodontic means alone. Alteration of the dental arches and alveolar processes to the maximum

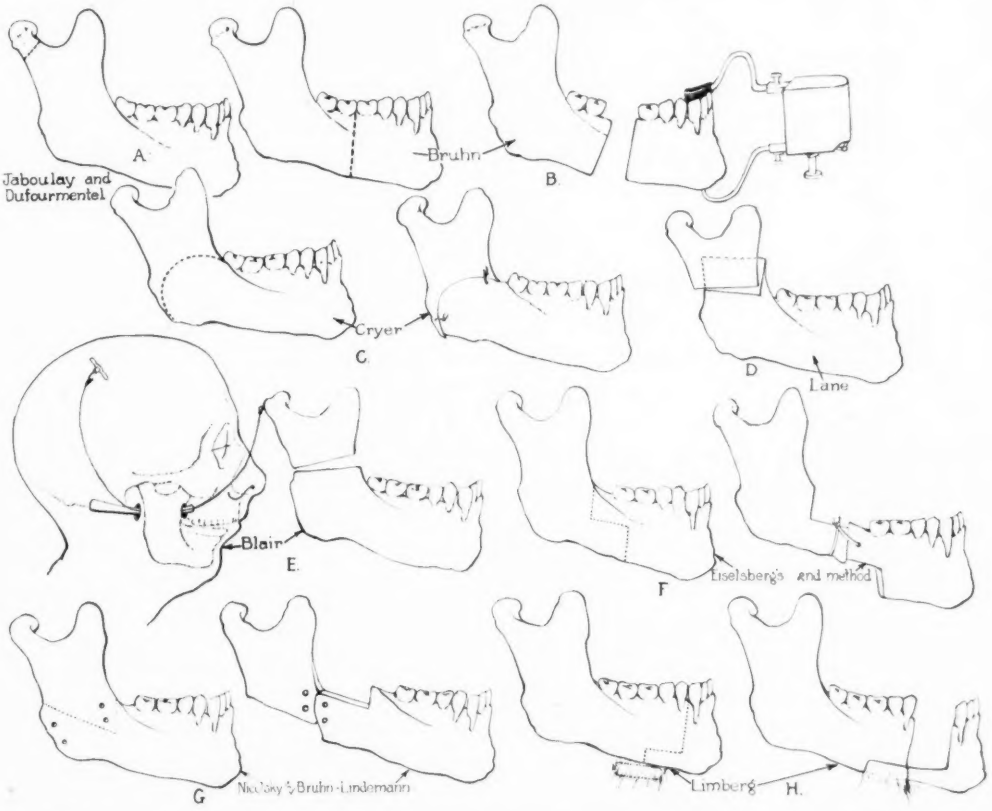

Fig. 4.—Schematic representation of fundamental types of osteoplasty of the mandible employed during the past four decades to lengthen or shorten the lower jaw.

degree, without a change in the position and length of the mandible, cannot improve the contour of the face. Not only is surgery required to secure the necessary radical correction of the mandible itself in its relation to the skull, but it is the only means of altering the conformation of the lower part of the face. In protraction or retraction of the mandible, a secondary deformity of the upper teeth and dental arch in their relation to the skull is always present. This secondary change is less severe in character and can be corrected to a considerable degree by subsequent orthodontic treatment. Preliminary diagnostic work must be

thorough and in addition to gross roentgen ray examinations, should include dental impressions and photognathostatic comparisons (Fig. 5).

The following types of mandibular deviations, classified according to the viewpoint of Landais,[16] may require surgical and orthodontic correction:

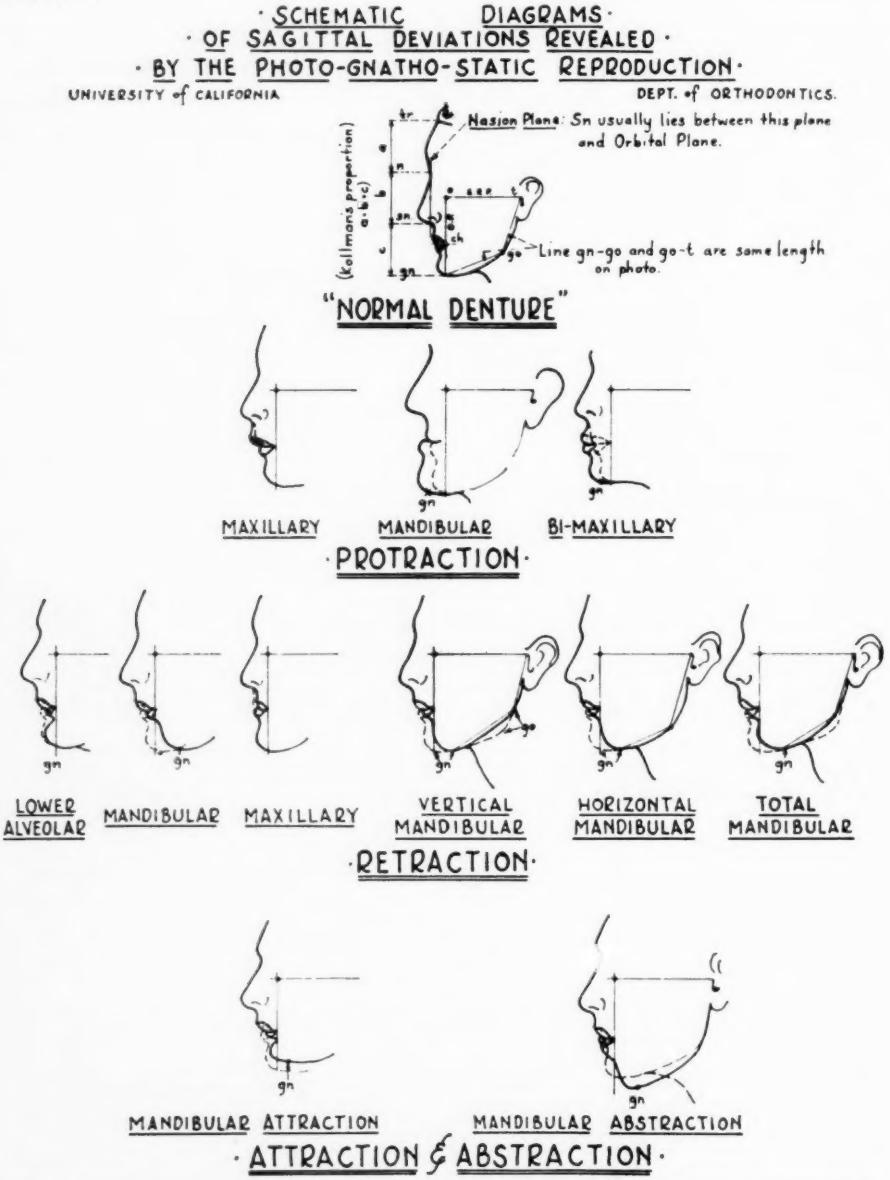

Fig. 5.—Photognathostatic representation of mandibular and maxillary abnormalities.

1. *Mandibular Prognathism*
   a. With molar contact and incisive supraclusion
   b. With molar contact and incisive infraclusion
   c. With molar infraclusion and incisive supraclusion

d. With generalized infraclusion
e. With generalized supraclusion

2. *Obtuse Mandible Without Prognathism*
Molar contact and generalized infraclusion otherwise

3. *Mandibular Laterognathism*
a. With molar infraclusion and incisive supraclusion
b. With molar contact and incisive infraclusion

Izard's treatise on orthodontia describes all these malformations clearly.[16] It is sufficient for the purpose of this work to enumerate these types of deformity and to add that all intermediate forms and combinations are possible.

This presentation concerns the surgical aspect of treatment. Preoperative dental adjustment and final prosthesis are primarily the concern of the orthodontist, but it should be emphasized that effective surgery is required to make possible the solving of his problem.

HISTORY

The operative correction of mandibular protraction has been a matter of surgical interest over the past four decades. The first operative correction of this deformity was effected in 1848 by Hullihen[13] who performed a partial osteoplastic resection of the jaw. Nearly fifty years passed before bilateral resection of the mandible was suggested again. Angle[1] is said to have advised complete bilateral resection of the horizontal rami for a case of progressive prognathism in 1898. It was not until 1906, however, that Blair[1] devised and performed an operation for shortening the mandible in which he resected a quadrilateral area of the entire body of this bone on each side. During the same year, Blair[3] devised and performed a subcutaneous osteotomy of the ascending rami for the purpose of lengthening the mandible (Fig. 4). Babcock[2] performed a modification of Blair's operation on the ascending rami, in 1909, by using a chisel through a very incomplete exposure. Aller[1] (1917) performed an intraoral excision with a wedge having an oral base at the occlusal surface of the second bicuspid.

An entirely different type of operation for prognathism had been suggested and performed by Jaboulay in 1898. It consisted of bilateral resection of both condyles. This method has been extensively employed in France by Dufourmentel and Darcissac.[11]

Lane, in England (1916), suggested osteotomy of the ascending rami. Various types of intraoral and extraoral resections of the horizontal rami were devised and performed during the period following 1906. Direct osteotomy of the horizontal rami was popularized in Germany and generally on the Continent, excepting in France, where bicondylar resection and osteotomy of the ascending rami continue to be the only operations in conspicuous use. Eiselberg (1906) and Pehr Gadd devised a

step-cut osteotomy for lengthening or widening the horizontal part of the mandible (Fig. 4). The ends of the cut fragments were fixed by wire ligatures. Brown (1918) and Bruhn and Lindemann (1921) recommended a vertical osteotomy of the mandible with a simple pulling apart of the fragments and secondary bone transplantation for lengthening operations.[8] A rather massive appliance was used to fix the fragments and secure traction at the same time[7] (Fig. 4). Cryer performed an operation by a curvilinear division at the angle and Nicolsky advocated a step-cut osteotomy in the same region (Fig. 4). Limberg[17] (1928) used a step-cut osteotomy with the implantation of a pedunculated graft from the rib for unilateral lengthening. The graft is made viable and pedunculated by transposition to the lower mandibular edge at the site of future osteotomy two or three months in advance (Fig. 4).

When the problem is one of shortening the mandible, excision of bone of suitable shape and dimension, with fixation of the fragments, is the operative plan used by advocates of direct section of the horizontal rami. Variations of the foregoing operations have been reported from time to time, but their precedent is established in one or another of the procedures mentioned above.

The surgery employed, to the present time, may be classified in three groups:

1. Bicondylar resection
2. Resection of the horizontal rami
   (a) With the excision of bone
   (b) With addition of bone
3. Osteotomy of the ascending rami

All recorded operative procedures have one or more serious objections included in the following categories: hazardous or uncertain technique; impairment of mandibular function; section of important nerves; oral contamination with wound infection; injury to the parotid gland or facial nerve; malunion; nonunion and osteomyelitis; devitalized or lost teeth; adherent scars from wound infection; prolonged disablement; and uncertain result. Bearing in mind the three fundamental requirements of surgery of the lower jaw, we may consider briefly the above enumerated groups.

BICONDYLAR RESECTION

Described by Jaboulay in 1898 (Fig. 4*A*), still vigorously sponsored in France by Dufourmentel and Darcissac,[10, 11] this operation, nevertheless, is the subject of severe and scholarly criticism by both Landais[15] and Bourget.[6] The outstanding objection to it consists of a permanent destruction of both temporomandibular articulations. Even when this functional handicap is accepted, the successful application of this proce-

dure is limited to the most infrequent variety of mandibular protraction; i.e., that in which prognathism and molar subocclusion are present in similar degree (Fig. 6*A*). Even in this type of case in which prognathism is marked or of greater degree than subocclusion, a loss of anterior dental contact will result (Fig. 6*C*). In condylar resection, recession of the mandible and shortening of the ascending ramus are inseparable. There is very little displacement of the mandible. The jaw is tipped back by the ascension of the vertical ramus. This procedure applied to the average type of protraction, with its obtuse mandible and open bite, will aggravate the malrelationship of the anterior teeth

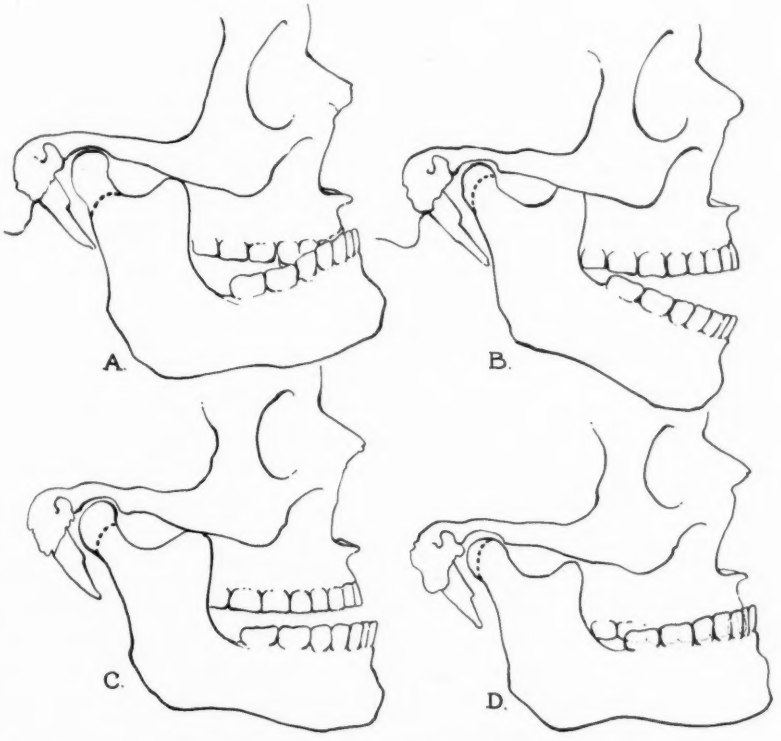

Fig. 6.—Types of prognathism and associated malocclusion. Bicondylar resection applicable to *A* only. *A*, With molar infraclusion and incisive supraclusion; *B*, with molar contact and incisive infraclusion; *C*, with generalized infraclusion; *D*, with generalized supraclusion.

to an irreducible interincisive gap. In other words, the element of protraction in the deformity is only partially corrected and the malocclusion of the teeth is actually increased.

RESECTION OF THE HORIZONTAL RAMI

This method offers the attractiveness of a direct attack, yet many objections to this procedure are obvious. Though a satisfactory final result is obtained in an appreciable number of cases when managed by those experienced in such types of resection, the history of this opera-

tive plan is one of universal complication and occasional disaster. No resection, osteoplasty, or osteosynthesis by graft for the purpose of lengthening or shortening the horizontal ramus of the mandible, can be performed without oral contamination of the site of osteotomy. Reports of complete operative resection of the horizontal rami indicate infection of bone or soft tissue with monotonous frequency. On rare occasions this complication may be of little consequence except for an ugly scar. On the other hand, instances of frank and prolonged osteomyelitis have followed such procedures. Mechanically, this operative plan does not alter the ascending rami. Mandibular protraction is a compound deformity and defects of direction and mass of the bone are always present in both rami. From a purely mechanical standpoint, resection of the horizontal rami cannot alter the faulty length or angle of the vertical rami. The unavoidable section of the alveolar nerves incident to any resection of the horizontal rami produces, at the least, a temporary trophic disturbance of the teeth, lost sensation in the chin, and some drooling. With the usual loss of teeth in the resected area, added to a probable infection of the wound, an adherent scar, and a period of disablement of possibly two years, this procedure should never be one of enthusiastic choice.

OSTEOTOMY OF THE ASCENDING RAMI

This procedure is the third and most desirable type of operative plan. The principle was introduced by Blair[3] in this country, and adopted by Kosteka, Bruhn, Pichler, and others on the Continent. It achieved a distinct advance over other methods as a solution to the problem of maldevelopment of the lower jaw. The advantages of section of the vertical rami lie in the absence of most of the objections mentioned in the preceding groups. Its special merit consists of a clean operative procedure in a logical region that permits displacement of the mandible en masse without destructive features. The technique in vogue up to the present time consists of the performance of a more or less horizontal section of the ascending ramus through a very short vertical incision at the posterior border of the lower ascending ramus. Here the parotid gland is displaced, and the periosteum is incised and separated from the inner surface of the ascending ramus. A Gigli saw is passed inward along this surface and externally around its anterior margin through the cheek (Fig. 4). The latter opening is protected by a trocar, and the osteotomy is completed. Landais, in discussing this procedure, recommended the use of a bayonet-shaped, small but stout-bladed saw, known as Joseph's saw.[15] This procedure effects a quickly performed section of the vertical rami and allows more or less free forward or backward displacement of the mandible. Though spectacular when successful, this technique again presents objectionable features, though they are somewhat less imminent than those of the other groups.

The procedure is blind in the same sense as subcutaneous tenotomy, but it involves far more important and numerous structures. The essential risks are: injury to blood vessels medial to the bone, malposition of fragments, injury to the parotid gland or duct, and oral contamination. Jamming of the Gigli saw on the second side may be a very disconcerting mishap. A final and important objection lies in a resulting uncertain line of osteotomy. It is impossible to select the desired line of section by this technique. An optimum direction and a prescribed position of transection of the vertical rami are required to effect proper transposition of the mandible. A study of the types of prognathism (Fig. 6) will illustrate these requirements of position and direction of osteotomy. In *A* and *B* of Fig. 6, the requirements of direction are reversed. In *A*, showing molar infraclusion, both vertical rami are too long, and in addition to posterior transposition of the mandible, it is advisable to shorten the vertical ramus as much as possible. An osteotomy directed downward and forward will not only permit posterior displacement but will shorten the vertical rami and reduce or correct the existing molar subocclusion as an entirely passive result of posterior transposition of the mandible. In *B*, Fig. 6, however, the direction of section clearly should be reversed. The ascending rami are short; the mandibular angle is obtuse; and molar contact blocks incisive occlusion. In extreme cases of this type, malocclusion would be only partially remedied by a straight linear posterior displacement of the jaw. Little change in the angulated plane of the lower teeth would be secured. The obliquity of osteotomy, therefore, should be directed forward and upward so that on posterior transposition a downward displacement with some lengthening of the vertical ramus also occurs. In the latter situation, posterior transposition alone will not effect a lengthening of the vertical rami because of the mobility of the condylar fragment and possible contractures of the masseter and internal pterygoid muscles. As soon as transection of the rami is completed, however, the anterior teeth easily are wired into occlusion with their maxillary neighbors. The skeletal (dental) traction so applied operates exactly as a lever of the first order with its fulcrum along the area of premature and excessive molar contact (Fig. 7*A*). The resultant expenditure of magnified force beyond this fulcrum must result in a descent of the vertical rami below the line of osteotomy. Such descent will take place regardless of the direction of the line of osteotomy. With a section in the proper obliquity, upward rotation of the condylar fragment (through pull of the temporal muscle) will be blocked by a continuous line of bone contact anterior to the condylar axes of rotation (Fig. 7*B*). From the standpoint of securing union, such continuous and close bony contact is, of course, most desirable. Fig. 7 illustrates these principles. The area between the mandibular notch and lingula available for section will vary from 12 to 14 mm. The width of the ascending ramus will approxi-

mate 40 mm. at the level of section. A rectangle of these dimensions may be constructed, and it will include the area of bone available for safe osteotomy. The maximum obliquity obtainable will be illustrated by the division of this rectangle through its greatest dimension. It will determine an angle of 20 degrees (Fig. 8).

Transposition along this limited angle of obliquity of the osteotomy cannot, per se, entirely correct severe molar or anterior subocclusion, but it permits distinct improvement when performed in the prescribed

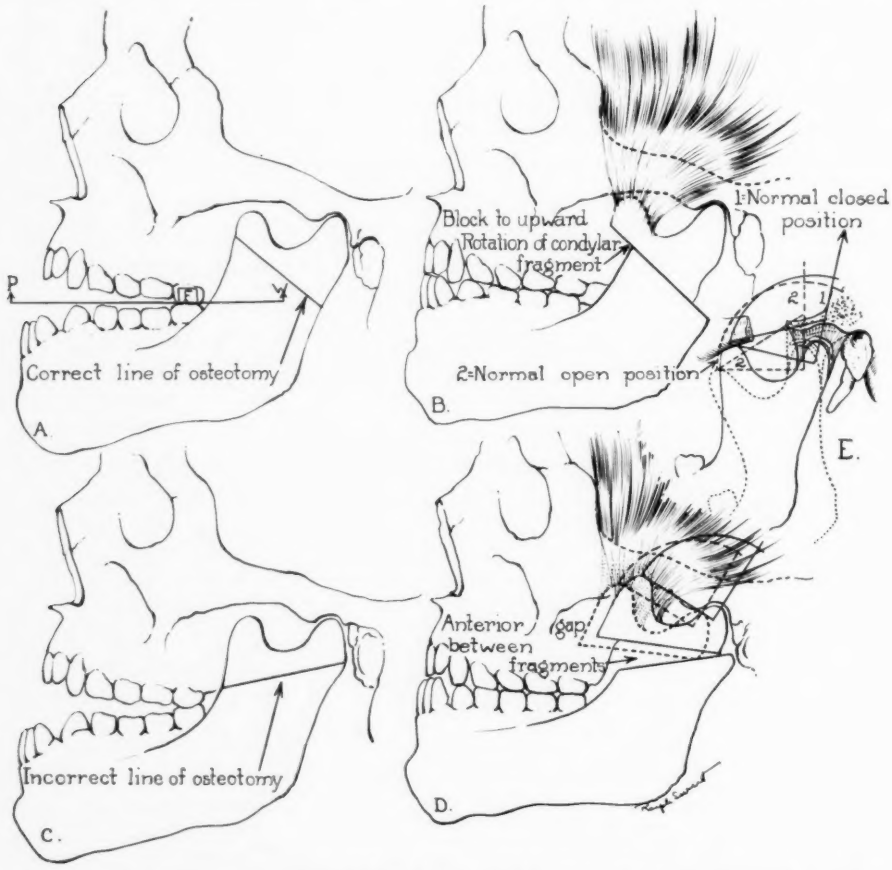

Fig. 7.—*A*, Leverage action of skeletal (dental) traction after osteotomy; *B*, correct direction of osteotomy illustrating a lengthening of the ascending ramus and a blocking to upward rotation of the condylar fragment; *D*, result of an incorrect direction of osteotomy, leverage action effective on lower fragment but without a block to displacement of the upper fragment; *E*, normal extreme positions of mandible with respective sectors of rotation 1 and 2. Compare with abnormal positions of *D*.

direction and thereby allows easier final orthodontic adjustment. Conversely, it becomes evident that blind procedures cannot possibly secure an optimum line of section even when such technique may be fortunate enough to give a resulting osteotomy through a safe area of division of the bone. Chance osteotomies of the blind type may result in a contraindicated obliquity of from 20 degrees to 40 degrees. Such misdirec-

tion of section would obviate operative improvement of occlusion and would greatly diminish the possibility of final orthodontic adjustment. Complete posterior displacement would be less readily secured, and the constant tendency to upward and forward rotation of the condylar fragment by the action of the temporal and external pterygoid muscles would be encouraged instead of blocked by the position of the lower fragment. Any condition of misdirected obliquity will result in a considerable anterior gap and in an upward rotation of the condylar fragments (Fig. 7*D*). Depending on the extent of the gap and the forward pull of the external pterygoid muscle, the rotated condylar head

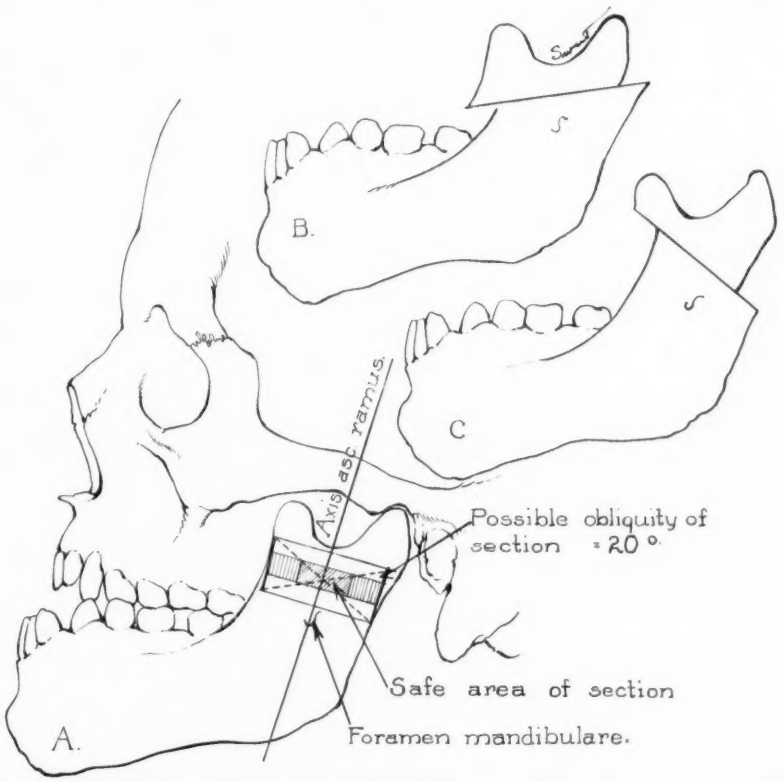

Fig. 8.—*A*, Possible obliquity of section determined by measurements. Any line of section should pass through the central safe area. Compare with Fig. 9 *B* and *C*. Extreme positions of obliquity.

may assume any relationship of the joint between the normal closed and open positions (Fig. 7*D, E*). In any anterior position of the condyle, a totally abnormal forward sector of rotation will be substituted for the normal sector (position) of rotation as the starting point of function of the joint. Despite successful transposition of the mandible, late articular disturbance can be the only possible result.

The measured distance from the bottom of the mandibular notch to the lingula varies from seven-sixteenths to ten-sixteenths of an inch depending on the size and contour of the mandible (Fig. 9).

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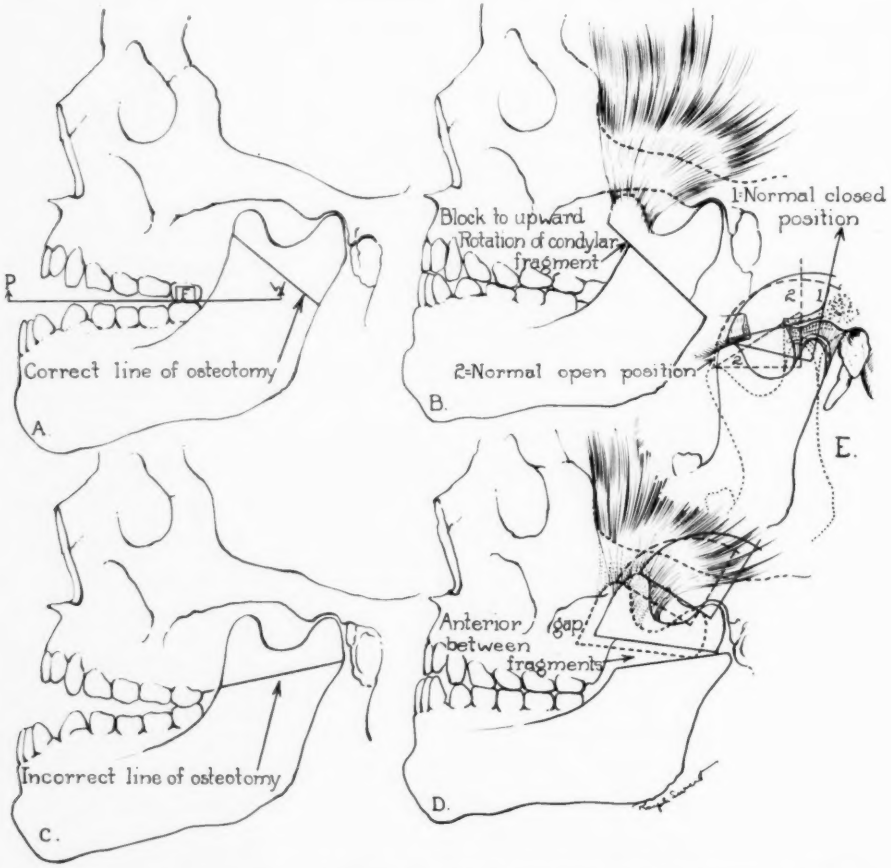

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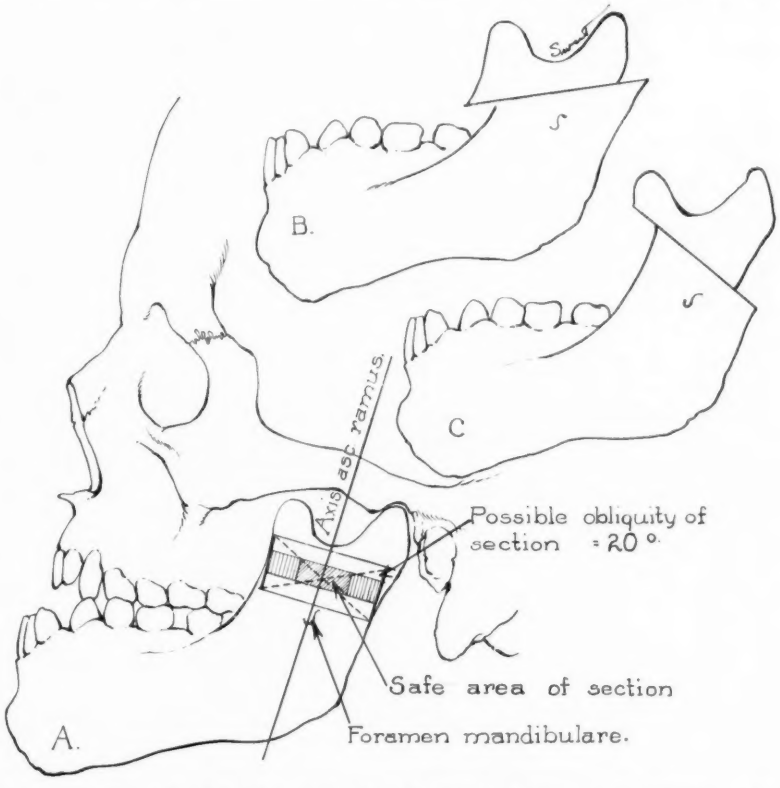

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The measured distance from the bottom of the mandibular notch to the lingula varies from seven-sixteenths to ten-sixteenths of an inch depending on the size and contour of the mandible (Fig. 9).

The inferior alveolar nerve enters its foramen three-sixteenths of an inch or less below the spine of the lingula and is very close to the inner surface of the mandible for a similar distance above the lingula. These measurements make evident the small margin of error permissible at the site of osteotomy. Selecting a middle third of this measured distance, a safe osteotomy can be performed only within a field of three-sixteenths of an inch through the midlinear area. (Figs. 8*A*, 9*C*.) Whether osteotomy is transverse or oblique, the line of section crossing the midaxis of the ramus should always pass through this safe area. If osteotomy is made too low, section of the inferior alveolar nerve and

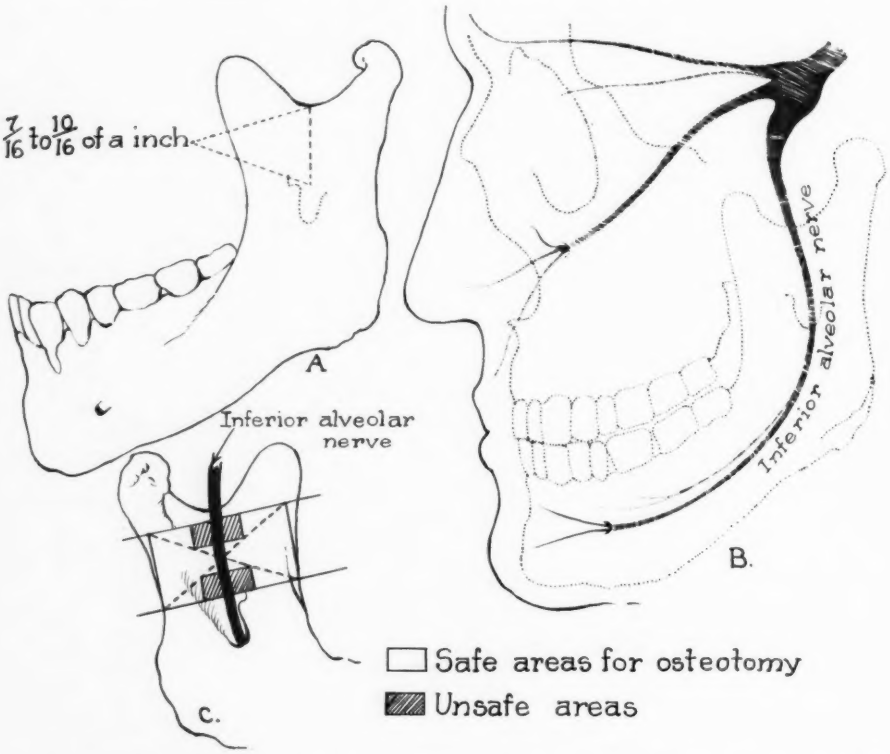

Fig. 9.—Medial relationship of sites of osteotomy. Compare with Fig. 8. *A*, Distance between mandibular notch and lingula; *B*, relationship of inferior alveolar nerve; *C*, area suitable for osteotomy.

accompanying vessels surely will result. On the other hand, if division of the bone is carried too high, there is a grave risk of splintering the upper portion of the ramus into the mandibular notch and so converting it into separated coronoid and condylar processes. The latter mishap invites displacement, disturbance of the temporomandibular joints, malunion, and laterognathism.

A direct anatomic approach securing adequate exposure of the ascending ramus meets the fundamental requirements of mandibular surgery, overcomes the objections to methods in vogue up to the present

time, and permits transection of the vertical rami in an optimum area that can be visibly identified and measured. The operative plan to be described was conceived in 1929 and first performed in February, 1930, without any known precedent for a direct approach to this area. Continued search of the literature, however, revealed a direct operative approach to the ascending ramus by Schmidt,[20] of Munich, and a further report of Schmidt's operation by Wymer,[22] also of Munich, in which transverse section was performed with a chisel ¾ cm. below the mandibular notch. Excellent cosmetic effect was reported.

Detailed operative technique and anatomic characteristics were not described. Photographs exhibit Schmidt's incision as extending from the posterior border of the ramus, opposite the middle of the lobule of the ear, obliquely upward and forward for a distance of about one and one-half inches toward the outer canthus of the eye. This approach would suggest itself as being too high to give adequate exposure of the upper half of the ascending ramus. The upper lobe of the parotid gland covers this area completely and danger of injury to the temporal and zygomatic orbital branches of the facial nerve is pronounced at this level and is a common accident with similar incisions for other conditions. At least a temporary paralysis of circumocular muscles was evident in some cases.

The present operation was devised because of the apparent lack of any known suitable exposure to the region of the upper half of the ascending ramus. Reported approaches to this region were dangerous and inadequate and failed to describe or illustrate anatomic characteristics.

OPERATION

All corrective orthodontic adjustments of maxillary teeth should be made prior to operation. Fixative apparatus to maintain the future position of the jaw should be applied before operation when dental fixation alone is required. I prefer fixed orthodontic bands on individual teeth to wiring, splints, or other oral appliances.

A horizontal incision one and one-fourth inches in length is developed across the cheek through the skin and subcutaneous tissue at the lower level of the lobule of the ear; it is then curved sharply, at a point about three-eighths of an inch anterior to the lobule, into a downward and forward limb for an additional one and one-fourth inches along the posterior border of the mandible (Fig. 10).

The convex flap so defined is dissected downward until the anterior border of the parotid gland is identified. This border of the gland courses obliquely downward and backward over the masseter muscle (Fig. 11). Careful dissection must be employed to avoid opening the parotid capsule; this is not difficult, however, if the proper plane of cleavage is determined. The parotid duct, which may appear in the

upper area of the exposure, must be avoided. Dissection at this point is well forward of all primary and secondary branches of the facial nerve and can be continued under the inner surface of the parotid capsule until this gland is mobilized sufficiently to permit easy upward and posterior displacement. The masseter muscle is next split longitudinally in the course of its fibers and retracted. The periosteum of the outer wall of the ascending ramus is split vertically in the midaxis of the bone and is elevated and retracted laterally (Fig. 12). Com-

Fig. 10.—Author's incision for direct osteotomy of ascending rami. Note relationship of facial nerve and parotid gland.

pletion of the approach permits exposure of the lower mandibular notch, the anterior and posterior margins of the ramus, and an area, about one square inch in size, of the outer wall of the upper half of the ascending ramus.

Adequate exposure is thereby secured for the identification of bony landmarks, for measurements, and for the performance of osteotomy at the proper site and in the proper direction. The site of osteotomy employed is approximately five-sixteenths of an inch below the midconcavity of the mandibular notch. In the majority of cases, the direc-

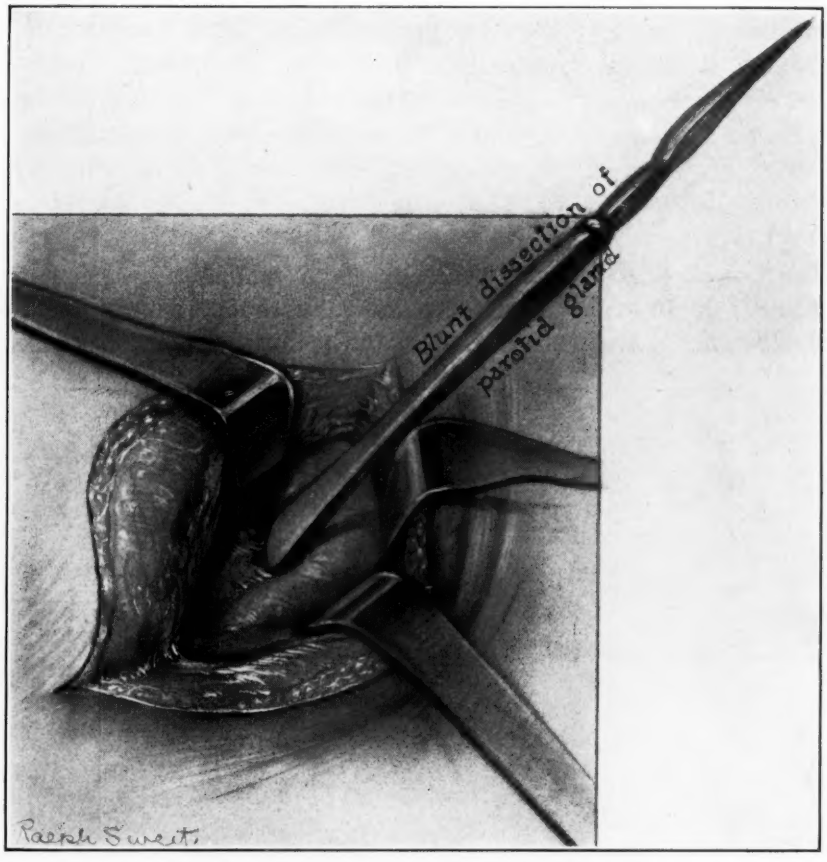

Fig. 11.—Extra capsular dissection of parotid gland.

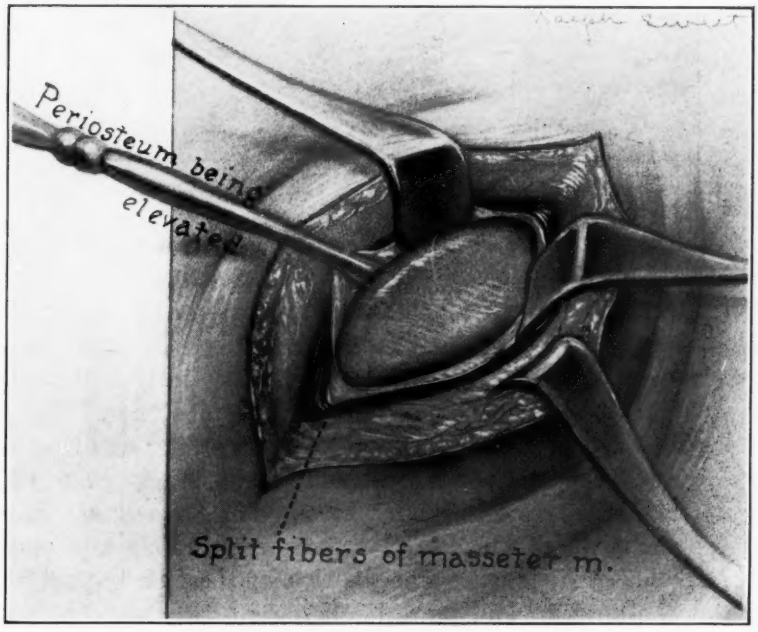

Fig. 12.—Exposure of outer cortex of ascending ramus.

tion of osteotomy may be either perpendicular to the long axis of the ascending ramus or parallel to the superior dental arch. Different mechanisms of occlusion and a mechanical need for lengthening or shortening the ascending ramus determine the obliquity of osteotomy (Figs. 6, 7), which will, therefore, vary with the individual requirement at hand. Measurement of the site and direction of osteotomy can be performed only through a direct approach and an adequate exposure.

The use of an osteotome, chisel, or Gigli saw in this region, five-sixteenths of an inch below the mandibular notch, is very awkward and extremely hazardous. There is available no surgical motorsaw small

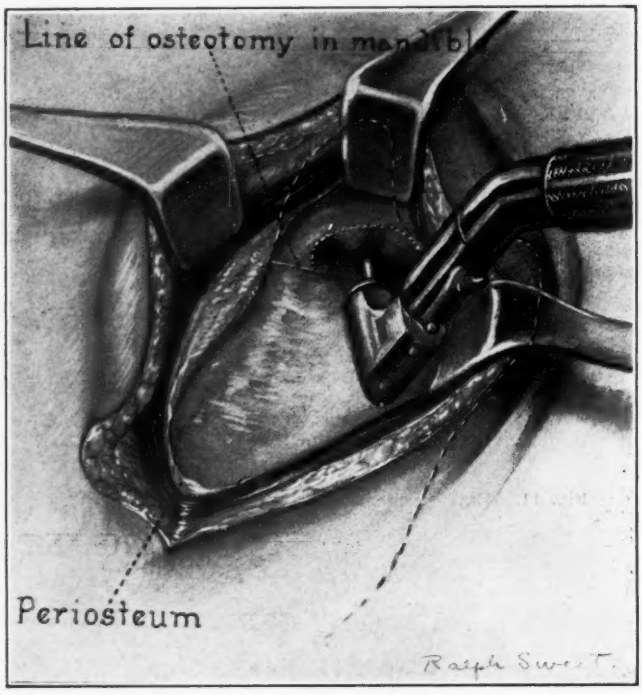

Fig. 13.—Osteotomy of ramus. Separating saw assembled into contraangle.

or fine enough to permit its use in this area. Up to the present time I have used a dental motor fitted with a cable drive and contraangle attachment into which a carrier shaft and separating saw nine-sixteenths of an inch in diameter are assembled. The contraangle attachment permits easy access through the wound and the application of the blade of the saw in the desired plane and direction of section. The blade of the saw is extremely fine, so that a very true, thin line of osteotomy can be secured (Fig. 13). Section should be definitely perpendicular to the surface of the ramus. Any beveling of the edges encourages lateral displacement of the condylar fragment and upward displacement of the lower fragment. The division of the last few millimeters of bone at the anterior and posterior borders of the mandible is com-

pleted with a fine osteotome because the circumference of the saw blade reaches beyond the limits of exposure in these positions. Closure is effected in layers without drainage.

At the completion of the osteotomy on the second side, the mandible can be transposed en masse, below the site of osteotomy to the desired position of occlusion in the orbital plane (Fig. 14). Fixation in position is secured by ligation with wire between the hooks of the orthodontic

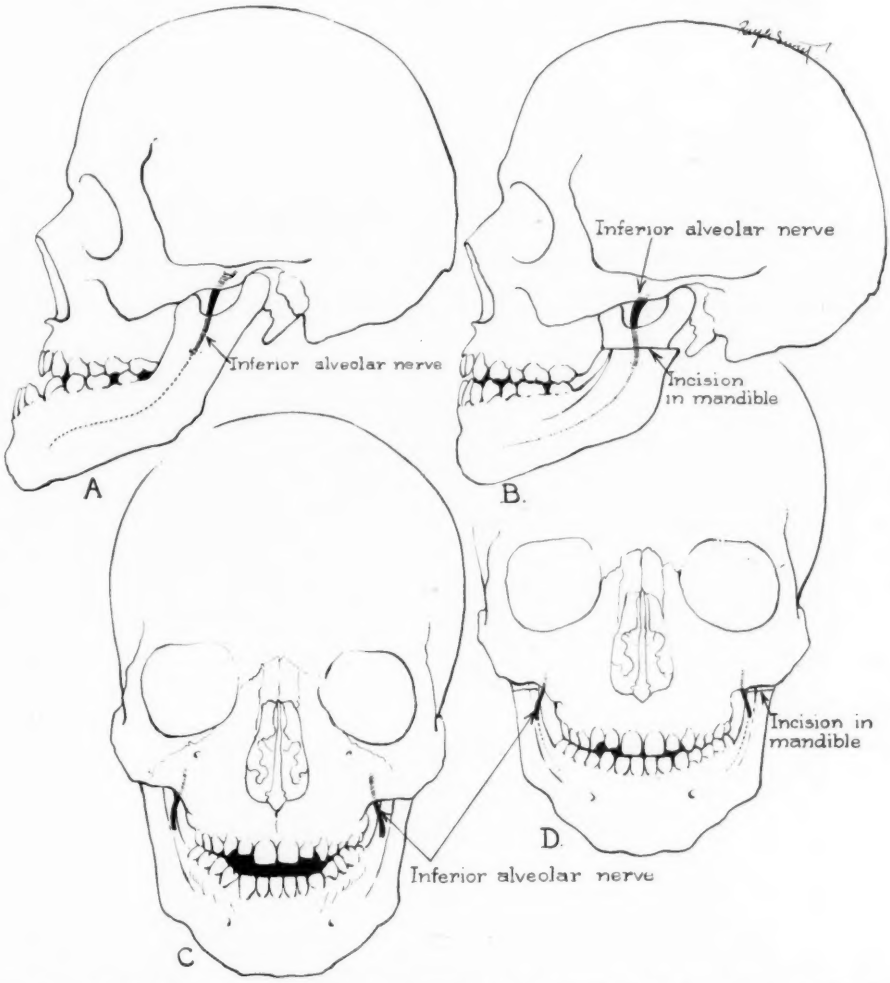

Fig. 14.—Case D. D. Drawings from x-rays before and after operation. *A* and *C*, Type of prognathism; *B* and *D*, line of osteotomy and result obtained. Note marked immediate operative improvement of occlusion and total correction of protraction.

bands on the upper and lower teeth. Complete immobilization should be continued for a minimum of four weeks, and partial immobilization for an added period of two weeks. Secure union will be present after six weeks. Little or no callus will be demonstrable by roentgenogram because of the very fine line of osteotomy. Total mandibular correction in prognathism is readily secured by this technique (Figs. 14-20). This

approach has been used fourteen times, for mandibular protraction, retraction, and repair of fractures of the ascending rami. In each case, healing of the wound has been entirely clean. Bony union has been

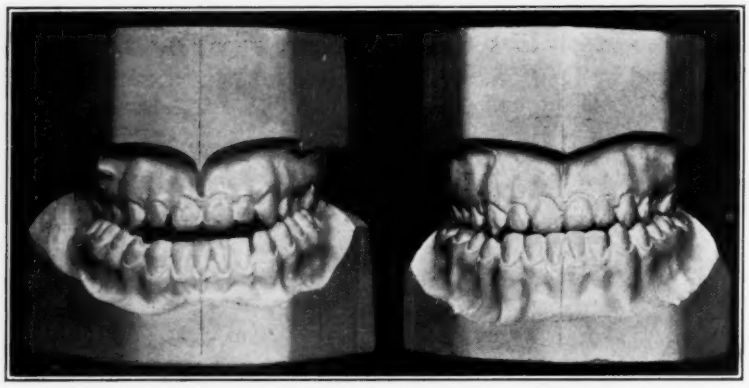

Fig. 15.—Case D. D. Pre- and postoperative dental impressions. Anterior view.

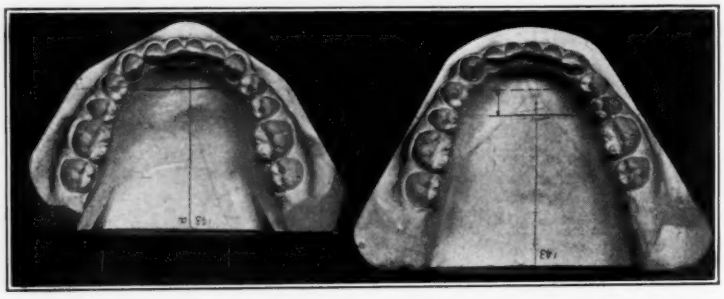

Fig. 16.—Vertical view showing extent of posterior shift and restoration of normal bicuspid relationship to orbital plane.

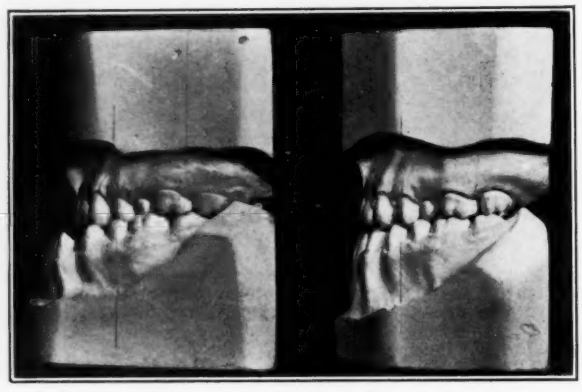

Fig. 17.—Pre- and postoperative lateral view.

complete and solid. There have been no instances of injury to the facial nerve, inferior alveolar nerve, or parotid gland. The strength of the muscles has not been impaired, and function of the temporo-

Fig. 18.—Case D. D. Pre- and postoperative photostatic anterior view. Note rounding of face and shortening of nasomental length.

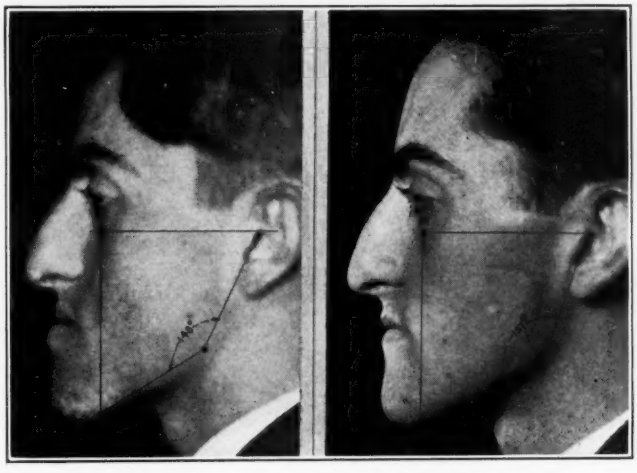

Fig. 19.—Pre- and postoperative photognathostatic lateral. Note improved angle of mandible, retraction of chin and restoration of normal lips and expression.

Fig. 20.—Pre- and postoperative lateral. Restoration of normal conformation of lower face with a distinct change of facial expression.

mandibular joints has remained normal. The external incision, though visible on close inspection, is not disfiguring and thins out into a soft, pliable scar.

The same operative procedure has been applied to cases of micrognathism (Fig. 10). Moderate deformities of retraction can be effectively corrected. Among the severe types, however, this deformity is complex, not only from a dental standpoint, but even more so from a cosmetic one. Such mandibles are seldom symmetrical and are frequently complicated by unequal atresia of the horizontal rami, with resultant laterognathism and obliquity of the chin. Bringing forward the body of the mandible does not entirely correct this obliquity.

In transection for prognathism, all muscular pull, except that of the internal pterygoid muscle, favors posterior displacement of the entire jaw bone; in severe microgenia, however, forward displacement after section, beyond an insufficient degree, is strongly opposed by muscles

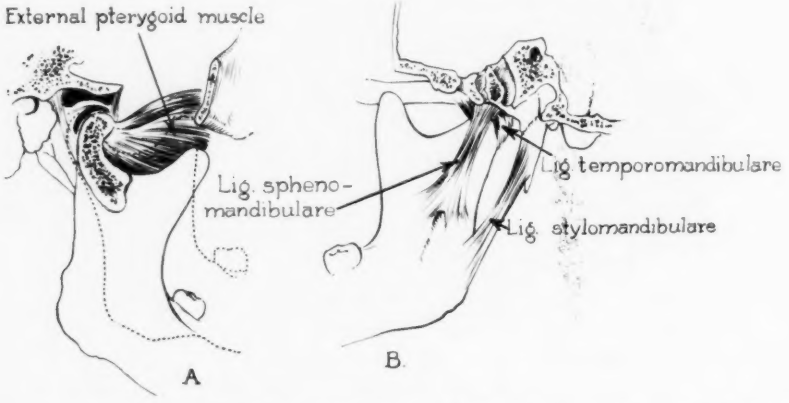

Fig. 21.—*A*, Action of external pterygoid in altering articular position of condylar head; *B*, these ligaments are relatively shortened and contracted in micrognathism. (Modified from Spalteholz, W.: Atlas of Human Anatomy, J. B. Lippincott, Philadelphia, 1923, vol. 1, p. 172.)

shortened through long-enduring contractures and by the stylomandibular and pterygomandibular ligaments (Fig. 21*B*). Prolonged skeletal traction will not entirely or permanently overcome this resistance to complete forward displacement.

A supplementary operative procedure is required to correct the obliquity of the chin and to complete the cosmetic effect of bringing the mandible forward.

A curved incision of sufficient length, coinciding with the anterior curve of the jaw, is developed well under the chin; and the skin and subcutaneous tissues are retracted upward. The symphysis and adjacent anterior mandible are exposed (Fig. 22). With the mental protuberance as an anatomic guide, a bow-shaped osteotomy with its central convexity at the symphysis is developed a distance of one-half an inch or more into the substance of the mandible (Fig. 23). The limbs of this

incision end just lateral to and above each mental protuberance (Fig. 24*A*). The plane of transection of the bone is parallel to the mandibular table and includes about one-quarter of its thickness (Fig. 24*B*). The convex flap so defined permits upward elevation with the ends of the curved osteotomy as hinges. Gentle upward elevation with a thin-bladed osteotome permits outward displacement of the bone flap through a series of incomplete fractures between the limbs of the curved osteot-

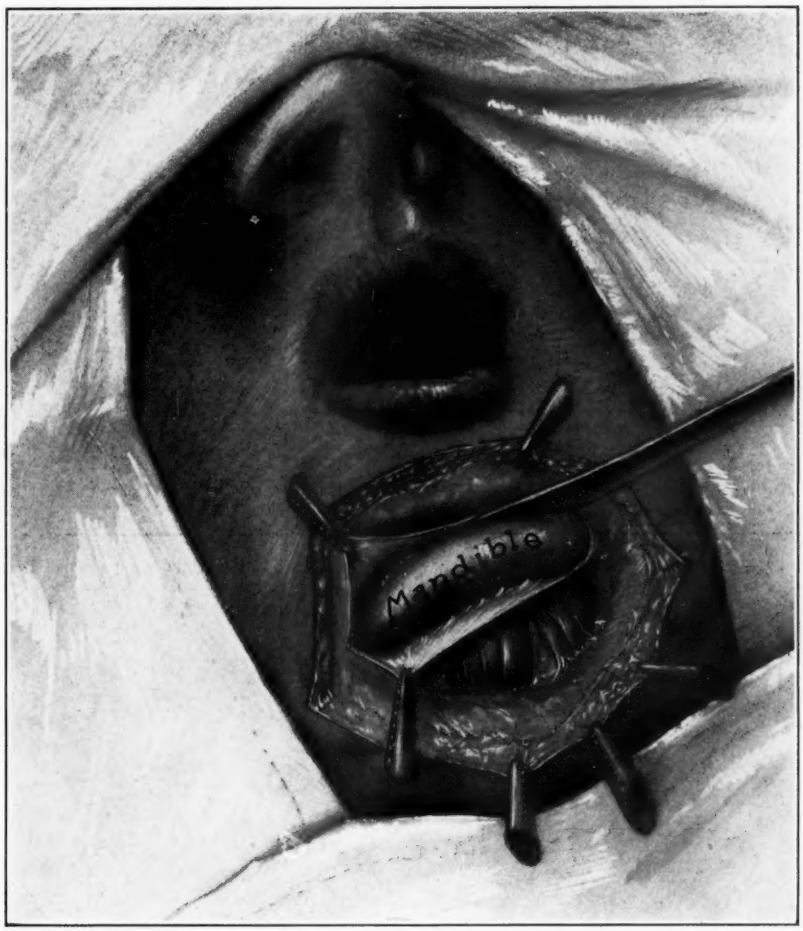

Fig. 22.—Case F. T. Exposure of the symphysis of the mandible.

omy (Fig. 24*A*, *B*). The periosteum should not be stripped to this height. It covers the fractured area and is a medium of nutrition. A graft of the proper size is removed from the iliac crest back of the anterior superior spine. The graft should include about one-half an inch of the subjacent thin iliac table continuous with the crest. The whole is then fashioned to the desired size and shape and wedged in snugly between the elevated mandibular bone flap and the main mass of the bone. No fixation of the graft is required. It should fit snugly

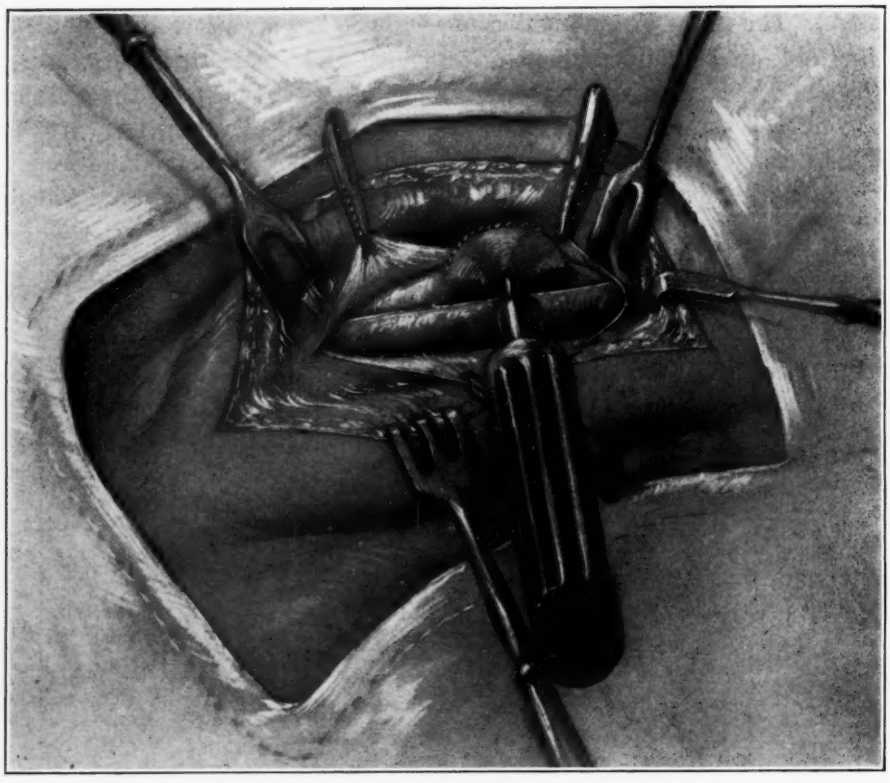

Fig. 23.—Partial osteotomy of mandible at symphysis with saw blade parallel to outer table.

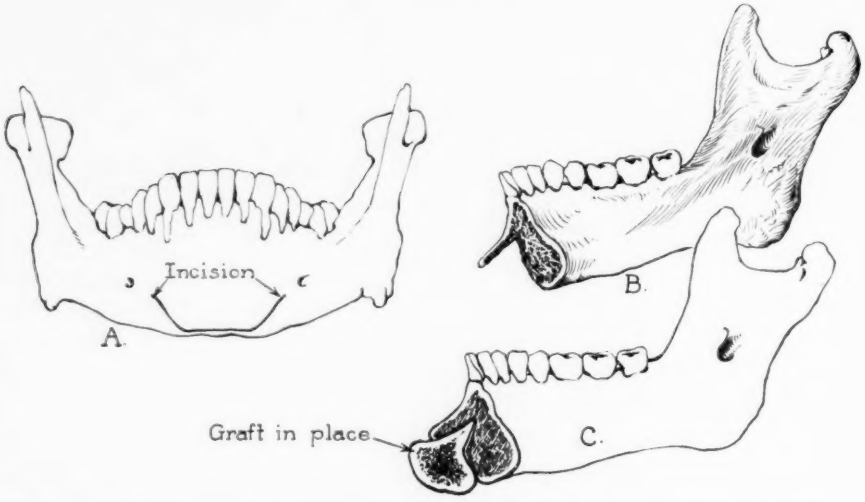

Fig. 24.—Semidiagrammatic representation of mandibular graft operation. *A*, Incision; *B*, elevated outer table; *C*, graft implantation.

without danger of displacement. If the elevated mandibular flap seems too free to offer security on this surface, two thin beef bone pegs can be driven through the elevated table and graft into the posterior mass of the mandible. The chin is built forward by this type of graft to a considerable degree (Fig. 25). It is also possible to correct much of the obliquity of the chin by slightly altering the depth and extent of osteotomy on the flat side or by increasing the length and depth of the graft on that side. The skin and subcutaneous tissues surrounding the chin should be sufficiently mobilized to permit closure without tension.

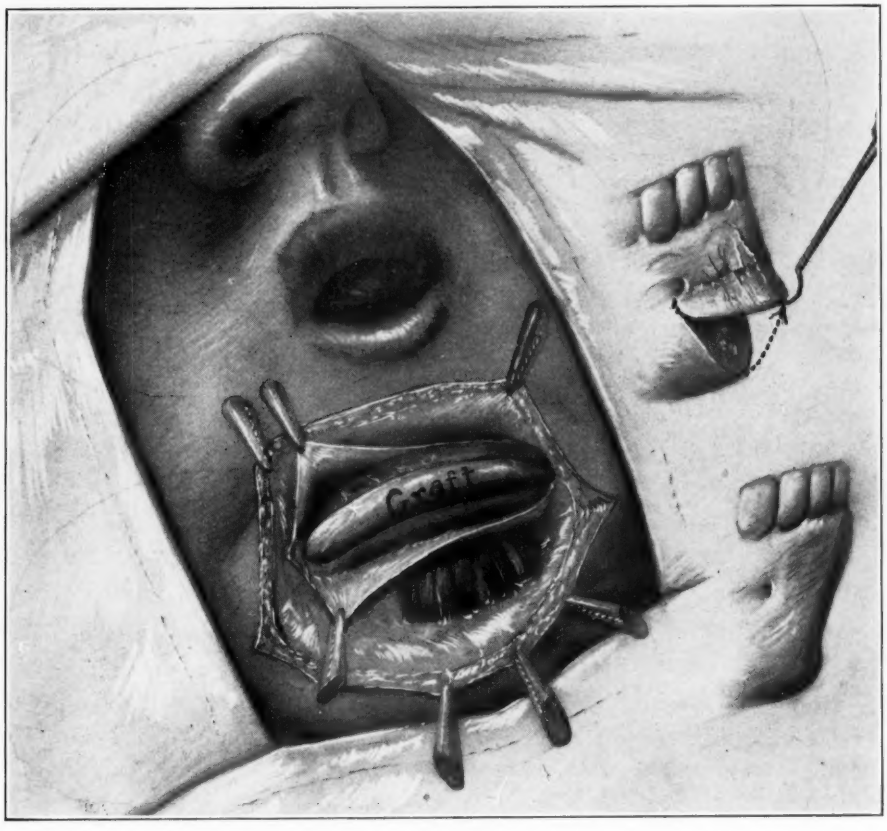

Fig. 25.—Case L. T. Graft from iliac crest wedged between the split tables of the mandible.

The thickness, roundness, and convexity of the iliac crest lends itself very well to restoring a prominent and evenly rounded chin, duplicating normal thickness. The relatively thin subjacent iliac tables permit wedge grafting under the mandibular flap and a restoration of the normal infralabial concavity. From a surgical standpoint, wedge implantation has several advantages over any type of onlay graft. A much greater security of position is offered, and there is a wide area of contact of bone on each surface of the graft. Conditions favoring early nutrition and later viability are optimum. The dangers of sequestration,

absorption, or displacement are minimal. Patients followed over a three-year period have exhibited no absorption of the graft. The scar is so placed that it is under the chin and not visible at the level of the face.

A final purpose of this presentation concerns the application of the approach for osteotomy of the ascending rami to osteosyntheses of certain irreducible and displaced fractures of the ascending rami.

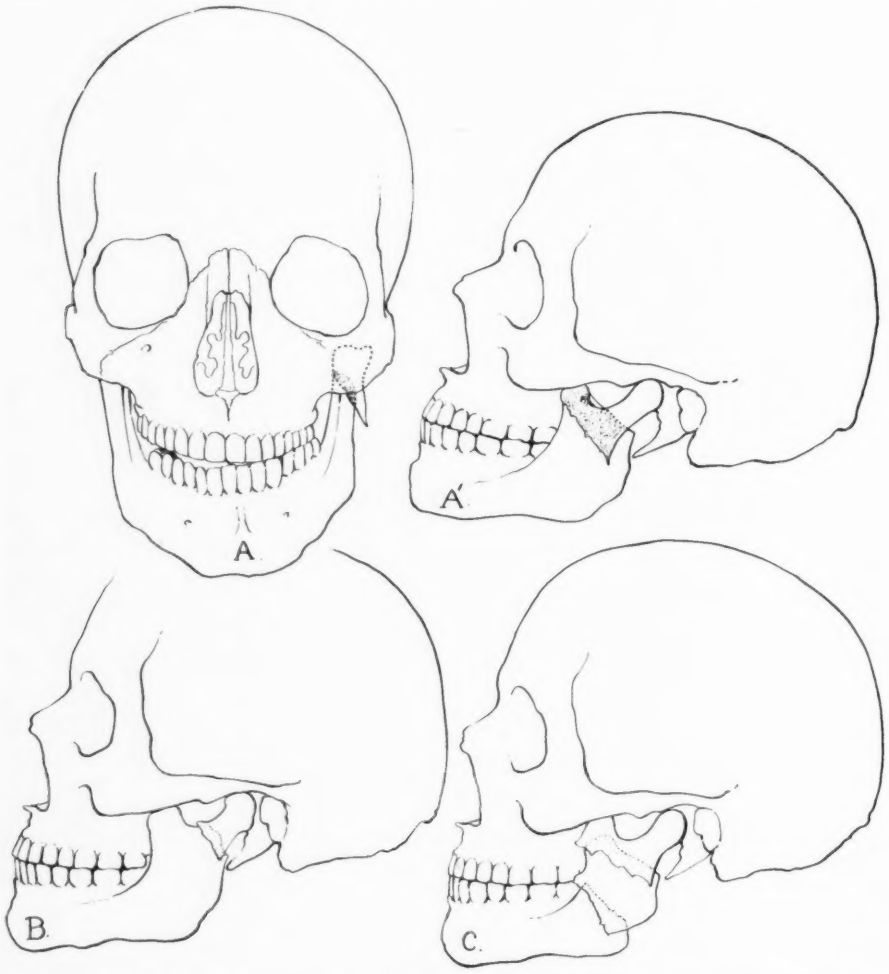

Fig. 26.—Types of fractures of the ascending rami usually requiring open reduction. *A*, Fracture left ascending ramus with outward displacement of the upper fragment, laterognathism, malocclusion and shortening of the left ascending ramus; *A'*, lateral view; *B*, low condylar neck fracture; *C*, double fracture of ascending ramus.

Conspicuous among these are the oblique sheared fractures of the upper ascending ramus (Fig. 26*A*). Some of these are reducible through conservative means when seen early.[14] Many are not. Such fractures often complicate a more obvious anterior fracture in relatively good position and go unrecognized or unattended.

A surprising percentage of patients with fractured jaws present themselves for treatment or are referred for treatment from several days to several weeks after injury.

The typical fracture mentioned has a sheared serrated edge with outward displacement of the short upper fragment. When unreduced, the pterygoid mass of the intact side loses its balancing opponents and pulls this side of the lower jaw forward and medially. The masseter and internal pterygoid muscles of the injured side lose the bracing effect of the condylar head against the base of the skull and elevate the mandible on the injured side, particularly if either the maxillary or mandibular molar teeth are absent. The result is usually a lateral deviation of the mandible to the injured side with a permanent lateral malocclusion of considerable degree. With failure of conservative measures or an omission of early treatment, operative correction offers the only possibility of removing the deformity and restoring proper mandibular function. Fractures of this character usually are not reduced because of an avoidance of surgical venture in this difficult area or an entirely mythical hope that occlusion will adjust itself and a "functional result" will be created.

A study of some twenty late cases of this character that received dental care of at least average efficiency suggests that there is no recognition of a possible indication for surgical treatment in this type of fracture until either bony union or well-established deformity exists. At such a time, surgical correction is far more difficult than it would have been at the time of injury, or is impossible. The criterion of reduction in this type of fracture is not an easily secured and accurate dental occlusion by ligation of teeth but is, on the contrary, a positive demonstration by roentgen ray of an accurate apposition of fragments. Fractures low in the condylar neck comprise a second group of fractures of the ascending rami which may produce malocclusion and late disturbance of the temporomandibular joint following union in displacement. These usually occur in an area of bare bone between the attachments of the pterygoid muscles medially and run from the mandibular notch downward and posteriorly through the posterior border of the ascending ramus (Fig. 26*B*). An occasional type that offers almost no possibility of reduction by conservative measures involves the angle and ascending ramus in a double fracture. The middle fragment between the two fracture lines is usually rotated in both horizontal and vertical planes (Fig. 26*C*). Correction of this type of injury requires surgical reduction. A fourth group of fractures of the ascending ramus or of the preangular area is made up of oblique fractures above and below the angle of the jaw with a resulting rotation of the ascending ramus around a vertical axis.[12] With a complete line of fracture such

rotation frequently occurs despite early conservative measures (Fig. 3). This rotation results in malunion, with lateral deviation of the jaw to the opposite side, malocclusion, and derangement of one or both temporomandibular joints; the latter is expressed clinically as local pain at these joints and limitation of mandibular excursion in opening the mouth. Fractures of the types discussed are all in a difficult area of approach. An attitude of ultraconservatism has been common among both surgeons and dentists. Proper reduction and fixation of the more serious types of fractures enumerated above require surgery. Such fractures of the ascending rami, requiring surgical correction, have been successfully managed through the same approach and exposure as described for correction of prognathism.

SUMMARY

Corrective surgery of the mandible should fulfill certain definite mechanical and functional requirements that deal with three essential considerations:

1. Anatomic restoration and symmetry of this bone as a whole.
2. Proper functional position of the temporomandibular joints.
3. The maintenance or restoration of proper dental occlusion.

The principles involved are discussed and illustrated. The history and present position of surgery applied to prognathism and micrognathism are defined and analyzed from the standpoints of technical objections and advantages.

Transection of the ascending rami through a direct surgical approach is advocated as the method of choice. The blind method of performing this operation in current use has some serious objections and falls far short of achieving a proper end-result. The surgical and mechanical requirements of transposition of the mandible are discussed and illustrated. A prescribed position and direction of osteotomy of the ascending rami is indicated in every case. The position of osteotomy should be constant within a central area of three-sixteenths of an inch. The direction of osteotomy should be predetermined by the angle and mass of mandibular deformity and by the type of malrelationship of the dental arches. A direct surgical approach offers the only means of meeting these requirements.

An operative procedure for the correction of mandibular protraction and retraction is presented. It consists of a direct surgical approach that permits visible osteotomy in the proper direction and in the area suitable for transection of the vertical rami. The method of performance is described and illustrated.

A supplementary operation to complete the cosmetic correction of micrognenia is described and illustrated.

The application of the surgical approach devised for the correction of prognathism and microgenia to osteosynthesis of certain fractures of the ascending rami is discussed.

The author wishes to express his appreciation to the Department of Orthodontics of the University of California Dental School for the use of material and the construction of dental impressions. He is greatly indebted to Dr. F. W. Schubert of that department for photostatic pictures and the photognathostatic diagrams.

REFERENCES

1. Aller, T. G.: Operative Treatment of Prognathism, Dental Cosmos **59**: 394-399, 1917.
2. Babcock, W. W.: The Surgical Treatment of Certain Deformities of the Jaw Associated With Malocclusion of the Teeth, J. A. M. A. **53**: 833-839, 1909.
3. Blair, V. P.: Operations on the Jaw Bone and Face, Surg., Gynec. & Obst. **4**: 67-78, 1907.
4. Blair, V. P.: Underdeveloped Lower Jaw. Report of Two Cases With Operation, J. A. M. A. **53**: 178-183, 1909.
5. Bourget, M.: Traitement chirurgical du prognathisme, Rev. de stomatol. **35**: 61-79, 1933.
6. Bourget, J.: Nouvelles remarques sur la resection bicondylienne et sur la section de la branche montante du maxillaire inferieur dans le traitement chirurgical du prognathisme, Rev. de stomatol. **37**: 152-159, 1935.
7. Bruhn, C.: Die Anwendung der Hakenextension in der Kieferchirurgie, Ztschr. f. Stomatol. **23**: 214-223, 1925.
8. Bruhn, C.: Zur Pathologie und Therapie der Maxillaren Gewebsueranderungen und Gewebslucken, Deutsche med. Wchnschr. **52**: 1587-1590, 1926.
9. Bruhn, C.: The Surgical-Orthopedical Removal of Deformations of the Jaws, Internat. J. Orthodontia **13**: 65-79, 1927.
10. Dufourmentel, L.: La traitement chirurgical du prognathisme, Presse méd. **24**: 235-237, 1921.
11. Dufourmentel, M., and Darcissac, M.: Quelques cas de résections condyliennes unilatérales et bilatérales avec presentation d'anciens opèrés, Rev. de stomatol. **34**: 340-346, 1932.
12. Hensel, G. C.: Management of Fracture of the Mandible, Surg., Gynec. & Obst. **55**: 238-243, 1932.
13. Hullihen, S. P.: A Case of Elongation of the Under Jaw, Am. J. Dent. Sc. **9**: 157-165, 1849.
14. Ivy, R. H., and Curtis, L.: Fractures of the Jaws, Philadelphia, 1931, Lea & Febiger.
15. Landais, M.: Le traitement chirurgical de la prognathie mandibulaire, Rev. de stomatol. **36**: 209-227, 1934.
16. Landais, Paul: Comment doit être conçu le traitement chirurgical des déformations mandibulaires: Prognathie et latérognathie, Rev. de stomatol. **36**: 98-103, 1934.
17. Limberg, A. A.: A New Method of Plastic Lengthening of the Mandible in Unilateral Microgenia and Asymmetry of the Face, J. Am. Dent. A. **15**: 851-871, 1928.
18. Pichler, H.: Doppelte unterkieferresektion in einem Fall von hochgradiger Progenie, Arch. f. klin. Chir. **150**: 444-464, 1918.
19. Pichler, H.: Ueber Progenie Operationen, Wien. klin. Wchnschr. **41**: 1333, 1334, 1928.
20. Schmidt, Georg.: Progenie Operationen, Deutsche Ztschr. f. Chir. **215**: 213-225, 1929.
21. Steindler, A.: Mechanics of Normal and Pathological Locomotion in Man, Springfield, 1935, Charles C. Thomas, Publisher, Chapt. VI.
22. Wymer, Immo.: Zur operativen Korrektur der Progenie, Deutsche Ztschr. f. Chir. **215**: 226-233, 1929.

CALCIFICATION OF THE SEMILUNAR CARTILAGES OF THE KNEE JOINT

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THE following case reports represent interesting observations concerning calcification of the semilunar cartilages of the knee joint, such lesions being extremely rare.

Fig. 1.—Anteroposterior x-ray of Case 1.

CASE 1.—(I. B.): S. S., male, aged sixty-six years, was first observed on June 15, 1928, stating that he was perfectly well until March of the same year, when without apparent cause he suffered pain about the right knee. Shortly thereafter,

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he observed the presence of a small localized swelling situated on the outer aspect of the affected knee joint. About June 1, 1928, he became totally disabled and was unable to bear weight on the affected limb. He suffered intense pain and required large doses of opiates for relief.

Examination revealed an elderly adult in excellent general condition, walking about with the aid of crutches and unable to bear weight on the right lower extremity. Other than the presence of an arcus senilis involving both eyes and the local condition he presented a normal picture.

Fig. 2.—Lateral x-ray of Case 1.

Local Findings.—The right knee joint was maintained in flexion; it was enlarged and presented a small localized swelling, the size of an almond, in the neighborhood of the external semilunar cartilage. This region was extremely tender to touch. There was no overlying redness of the skin and no evidence of local heat. The angle of greatest extension of the joint was 150 degrees, and the angle of greatest voluntary flexion was 130 degrees. Movements of the joint were accompanied by extreme pain and muscle spasm.

Laboratory Findings.—X-rays brought by the patient revealed the presence of a calcification of the external semilunar cartilages of both knee joints, that on the

Fig. 3.—Anteroposterior x-ray of Case 2.

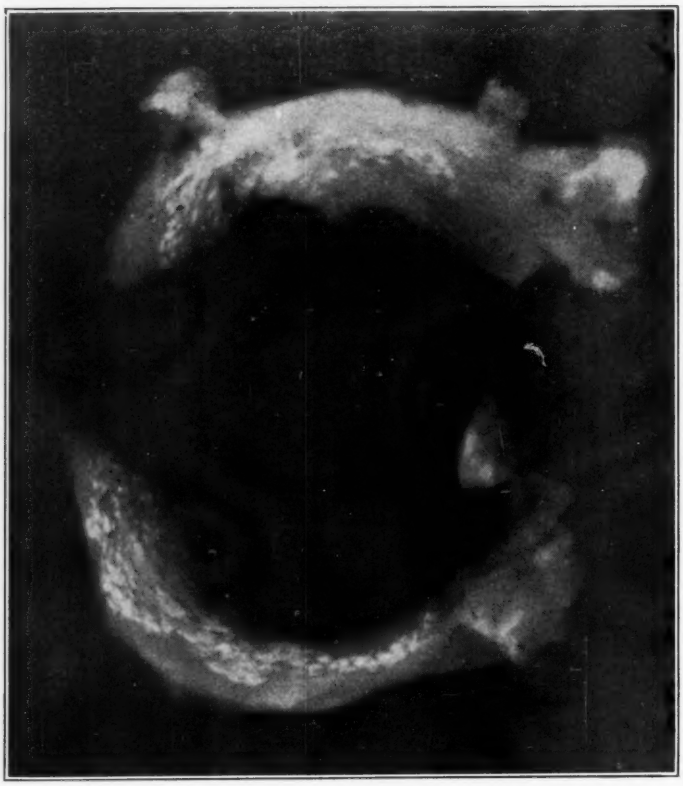

Fig. 4.—X-ray of specimens removed from Case 2.

right side being somewhat thicker than its fellow; and the overlying soft tissues were increased in density. Blood uric acid and blood sugar determinations were within normal limits.

The patient was admitted to the Hospital for the Ruptured and Crippled, and at the time of operation, a five inch incision was made over the outer aspect of the right knee and the previously described cystic swelling encountered. This enlargement was found to be intimately attached to the external semilunar cartilage and communicated directly with it. The cartilage was rather thick and somewhat loose in its anterior half, although not completely detached from the neighboring tissues.

Fig. 5.—Photoenlargement of specimens, Case 2.

Both the external semilunar cartilage and its cystic attachment were removed. The wound was closed in the usual manner and a plaster of Paris circular bandage was applied from the toes to the groin with the limb in extension.

The patient made an uneventful recovery and was discharged from the hospital walking about with the aid of crutches. He received physiotherapy thereafter, and when observed on August 31, 1928, he had fully recovered the use of his right knee joint, and he suffered no subjective phenomena.

For reasons other than those pertaining to himself, he returned on July 6, 1932, and was kind enough to submit to reexamination. He stated that he was quite well and had no symptoms referable to either knee joint. X-ray examination of the right

knee at this time disclosed a joint that showed no evidence of recurrence of the calcification, although there was some increased lipping of the external tibial condyle. This, however, caused no symptoms.

CASE 2.—(D. M. B.): E. K., female, housewife, aged forty-four years, was first seen at the St. Luke's Clinic on March 16, 1935, complaining of acute pain in her right knee of six weeks' duration. During this period the knee would occasionally swell and then recede spontaneously within twenty-four hours. She stated that she had the same symptoms some three years ago which, however, passed over following the application of heat and massage. There was no history of injury nor locking and no generalized infections.

Examination at the time of admission to the clinic revealed the following: Extension was possible to within 5 degrees of normal and flexion of the joint was possible to within 30 degrees of normal. Movements were accompanied by the feeling of a fibrous block, and there was pain and muscle spasm on the extremes of motion. There was no crepitation palpable nor was there any free fluid within the joint. The soft tissues about the joint were generally thickened and accompanied by tenderness throughout. There was no evidence throughout the anatomy of any arthritis or other calcified areas.

The x-rays disclosed the presence of calcified menisci.

On April 12, 1935, an operation was performed, the joint being opened through four anterolateral and posterolateral incisions, and both menisci were carefully removed in their entirety. The pathology found at operation showed diffuse calcified areas in both menisci with slight thickening of the cartilages. The articular cartilage surfaces of both the tibia and femur were normal. The synovia was of normal thickness and only slightly injected near the area of attachment of the semilunar cartilages.

The postoperative course was uneventful, and five months following the operation, the patient exhibited a normal range of motion of the knee joint, and there were no residual subjective or objective symptoms. Examination one and one-half years postoperative (September, 1936) showed a normal knee joint both as to contour, motion, and power. There were no symptoms and no evidence of limp. X-rays taken at this time were negative for bone and joint pathology.

Calcification of the menisci has been observed in six instances, and three cases were reported by Israelski and Pollack.[1] Of the six cases recorded, three patients exhibited calcification of the intervertebral disks of the spine, and one patient was suffering from diabetes.

Israelski[2] cites an instance of an operative observation and states that: "In only one case was operation undertaken and the meniscus examined histologically; it showed a depletion of cartilage cells and a predominance of fibrous tissue, and a diffuse infiltration with calcium." The pathologic sections of the first case here recorded showed similar findings.

ETIOLOGY

Aberrant calcification has frequently been observed in various parts of the body, particularly under the title of calcinosis. Calcinosis has been found more often in the soft tissues about the finger tips and also in other parts subject to traumatism. Aberrant calcifications are ap-

parently due to poor circulation of the affected region with resultant failure of normal calcium content of the part to be absorbed into the blood stream.

CONCLUSIONS

1. The lesion has its onset from middle life. 2. It may be bilateral. 3. There is no direct relation to traumatism. 4. Calcification of the semilunar cartilages may occur without resulting in objective or subjective symptoms. 5. Operation is only necessary when the lesion is complicated by the presence of degeneration with its resultant cystic formation, or when the cartilage becomes loosened and gives rise to symptoms referable to a dislocation or laceration.

REFERENCES

1. Israelski, M., and Pollack, H.: Ueber Kalkablagerungen in den Kniegelenken und Intervertebralscheiben, Beitr. z. klin. Chir. **150**: 476-489, 1930.
2. Israelski, M.: Meniscus Calcification. Roentgen Findings in Disease of the Menisci, Am. J. Roentgenol. **25**: 85-87, 1931.
3. Mercer, W.: Orthopedic Surgery, Baltimore, 1936, William Wood & Company.

Editorials

Ureterointestinal Anastomosis

WAYS and means of doing without a bladder have been long weighed in the back of the medical mind. Nephrostomy, pyelostomy, and ureterostomy, while answering temporary requirements, have many disadvantages. Any artificial reservoir for urine, even with constant care, will stink at times and, in addition to this unpleasantness, the continual care of dressings, tubes, and bags hinders social life and activity. Shunting the urinary stream into the bowel offers continence, cleanliness, and freedom from all this daily care. This method of diversion, however, although ideal in theory, has drawbacks in practice. Peritonitis, obstruction of the bowel, pyelonephritis, or anuria from ureteral obstruction spoil, at the outset, many otherwise good implantations. Occasionally renal insufficiency, in the after years of those surviving, marks the seriousness of isolating the upper urinary tract from all means of manipulation. Excretory urograms may show the changes brought about by ureteral obstruction or chronic infection, but relief by dilatation or lavage is no longer possible. Nevertheless ureterointestinal implantation is looked upon as sound surgery, is being used more and more, and shows improvement in methods and results. This is apparent from the tone of the contributions in this issue of SURGERY by Higgins, Walters, and Foley.

No one doubts the applicability of this method in cases of exstrophy, and the results have been surprisingly good. Its use, with cystectomy, for cancer is an entirely different problem in the minds of some surgeons. The idea of dissimilarity probably arises from the much higher mortality found in the use of implantation for the relief of cancer. This is really not the fault of the method. Excluding the aged and infirm, an adult should withstand surgery as well as an exstrophic infant. The association of cancer (not the age of the patient) gives rise to the higher mortality (from 10 to 20 per cent higher). Implantations for vesicovaginal fistula, for example, result as favorably as those for exstrophy. Implantation in connection with cystectomy for cancer fails more frequently because of the delay in its application. The cancer has recurred perhaps after years of irradiation or after partial resection and, as a forlorn hope, the surgeon now does what he should have done when the cancer was first discovered. He is too late. The cancer has spread. The bladder is adherent. Removal is difficult. Bleeding is profuse and

the patient dies at the time from shock or later from carcinomatosis. Early diagnosis and the immediate use of implantation with cystectomy for vesical carcinoma, incurable otherwise, will result just as favorably as for exstrophy and vesicovaginal fistula.

In surgery, the simplest way of doing a thing usually proves to be the best way. This seems particularly applicable to ureterointestinal implantation. Every method that can be imagined has been tried and the simpler, less technical, more direct methods are superior. No longer need peritonitis be feared, provided the anastomosis of the ureter to the bowel is secure. Peritonitis comes from leakage after operation, not from contamination at the time. Infection of the urinary tract (ureteritis, pyelonephritis) is the big obstacle, both at the time of implantation and later. A few patients miss urinary sepsis entirely and show perfectly normal upper tracts twenty or thirty years later. Many have temporary or periodic inflammatory reactions without permanent damage to renal function. Others die early from acute, or later from atrophic, pyelonephritis—usually associated with some degree of ureteral obstruction. Until the factor in technique responsible for ascending infection is known and corrected, or measures of therapy both preventive and curative are discovered, experience teaches that implantation of the ureters separately (in two stages) is much safer than bilateral implantation at the same operation.

Of all the different principles of surgery which have been tried out in the effort to solve the problem, that of submucous implantation has been most widely used. An oblique entrance is the natural way for the ureter to enter the muscular wall of the bowel and lowers the risk of kinks and blocks. Above all, the principle of submucous implantation eliminates most successfully the danger of leakage of intestinal contents afterward and thus removes the fear of peritonitis. That valve action at the opening of the ureter into the bowel is secured is doubtful. Active unobstructed peristalsis of the ureter itself is the best safeguard against reflux and ascending infection.

The results of ureterointestinal implantation in connection with cystectomy in the treatment of cancer will improve, therefore, in proportion to its earlier application; that is, at a time when removal of the bladder is not too difficult and at a time when its removal will get rid of all the cancer. Results will improve also with better standardization of the simpler methods and with the greater skill of performance which experience alone can give. At present, unilateral implantation in two stages is safer than bilateral implantation in one stage.

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The Treatment of Suppurative Pericarditis

SUPPURATIVE pericarditis is generally considered a rare condition, and the small number of cases reported in the literature supports this idea. However, a review of the autopsy statistics of any large general hospital will show that the disease is of relatively frequent occurrence but that it is not often diagnosed clinically. Since adequate treatment is impossible without a correct diagnosis, it is essential that physicians and surgeons keep in mind the etiology and important symptoms and signs of suppurative pericarditis and examine all suspicious cases repeatedly, this examination to include roentgenography and fluoroscopy. If this is done, the correct diagnosis will be made in the early stage of the disease in a much higher percentage of cases.

Pericardiocentesis may be indicated in acute pericardial infections either for diagnosis or for the temporary relief of pressure. It should be used for diagnosis when it is impossible to be reasonably certain of the presence of pyogenic infection by other means; and it is indicated as a therapeutic measure when there is a large collection of fluid producing a marked increase in pressure. Since the procedure is not without danger, it should be used only when there are very definite indications for it, and then every precaution should be taken to avoid infecting the pleurae or peritoneum, or injuring the wall of the heart or a coronary vessel.

While there are occasional reports of cures by aspiration, they are exceptional; and the mortality rate in cases treated by nonoperative methods approaches 100 per cent. However, approximately 50 per cent of those patients treated by surgical drainage recover. Drainage, therefore, is the treatment of choice and should be carried out when there is a demonstrable collection of pus in the pericardial cavity, regardless of the other conditions present. The only reason for delay is that under certain circumstances the patient may be made a better surgical risk by such preliminary procedures as blood transfusion and aspiration. After such preparation as seems necessary, adequate drainage should be established though the patient may have serious infections elsewhere and even in the presence of septicemia.

Drainage should be established before the pericardial fluid becomes purulent, for if this is done, the patient absorbs less toxin; the circulation does not suffer as great embarrassment from the increased intrapericardial pressure, and the distended pericardial sac contracts more rapidly, thus hastening cure. The early drainage of pericardial infections does not give rise to the same dangers as the early drainage of pleural infections; but as the pericardium and epicardium adhere more rapidly, they are more apt to wall off pockets of pus. This is probably due to two factors, the more rapid contraction of the pericardium and the occurrence of greater amounts of fibrin in the nonpurulent fluid.

The formation of such pockets can be prevented by passing a well-lubricated, gloved finger or a catheter around the heart once or twice a day for the first few days.

A number of methods for draining the pericardial cavity have been recommended and any approach which gives a good exposure with a minimum of shock and which does not expose the peritoneal and pleural cavities to infection may be used. The approaches most commonly used are the transsternal, the subcostal or costoxiphoid, the lateral or posterior, and the left parasternal. The transsternal exposure of the pericardium has no apparent advantages and has the very definite disadvantage that it does not give satisfactory access to the interior of the sac, so should be used only under exceptional circumstances. Theoretically, the subcostal approach may give more ideal drainage as it exposes the most dependent part of the pericardial sac, but it adds to the technical difficulties of the operation and also exposes the pleural cavities and the peritoneal cavity to the danger of infection. The lateral or posterior approach gives good dependent drainage but this is apt to be obtained at too great a sacrifice. If the left pleural cavity is obliterated by adhesions, the pericardium may be exposed in this way without especial danger; but if this is not the case, the danger of infecting the left pleura is too great. Furthermore, the depth of the wound necessitates the use of drainage material, which is generally undesirable in the pericardium.

The left parasternal approach is easily performed under local anesthesia and when properly carried out does not produce shock. It does not give dependent drainage when the patient is in the dorsal recumbent position, but this disadvantage is largely compensated for by the constant motion of the heart and the respiratory movements, both of which promote evacuation of the fluid. Furthermore, the patient may be turned on the left side or even in the prone position at sufficiently frequent intervals to keep the pericardial sac well drained. Two cartilages should be resected; the fifth and sixth are usually selected, but the fourth and fifth or the sixth and seventh will give equally satisfactory drainage. Resection of the fourth and fifth cartilages has the advantage of not exposing the lower, fused cartilages to infection, except in those instances in which the fifth and sixth are joined by a parasternal cartilaginous band.

The incision in the pericardium should be made in line with the skin incision and its edge should be sutured to the fascia or skin to avoid the necessity for using drainage material. If, for any reason, it seems advisable to insert drains, those made of rolled rubber dam are preferable to rubber tubes or cigarette drains, for tubes may cause serious damage to the wall of the heart or a coronary vessel and cigarette drains serve no useful purpose. The establishment of closed drainage by the

trocar-cannula method has no place in the treatment of suppurative pericarditis. It is unnecessary; there is danger of injuring the heart if the epicardium and pericardium are adherent anteriorly, as is not infrequently the case; and it increases the chances for the development of pus pockets posterior to the heart.

The treatment of acute suppurative pericarditis may be summarized as early adequate drainage and subsequent separation of fibrinous adhesions to prevent the formation of pus pockets.

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Recent Advances in Surgery

CONDUCTED BY ALFRED BLALOCK, M.D.

RECENT ADVANCES IN PROSTATIC SURGERY

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DURING the last decade there have been more radical changes in the surgery of the prostate gland than in any other branch of surgery. Twenty years ago there was an active controversy between the advocates of perineal and suprapubic prostatectomy. Each had its place in urologic surgery; both, when skillfully performed, gave excellent results and had a low mortality. Urologists of both schools then turned their attention to the refinement of their technique. Within the last seven years, a radical change has occurred; attention has been focused on the transurethral approach to the enlarged prostate. This has progressed with such enthusiasm that the controversy now is between the prostatectomist and the transurethral resectionist. Advances have also been made in the treatment of malignancy and inflammatory conditions of the gland. Endocrinology is becoming an active subject for investigation; the interrelationship of the prostate and the ductless glands forms an interesting chapter in recent advances in urology.

Inflammatory conditions of the prostate have been attacked by intravenous as well as local therapy. Young and others feel that these infections clear up more rapidly when treated simultaneously by both methods. Whether the benefit is derived from the severe systemic reaction, such as is seen after foreign protein injections, or from the specific drugs used, has not been definitely determined. In the last few years, hyperthermia therapy, by one means or another, has become very popular in the treatment of inflammatory conditions, particularly when the etiologic factor is the gonococcus. Many conflicting reports have been published recently on this subject. In the Duke Hospital over five hundred patients suffering from various diseases have been treated in this manner. Raising the body temperature to 41° C. and maintaining it at that level for a period of seven or eight hours is heroic therapy and is not without distinct danger to certain patients. It is to be recommended in urologic cases only when there is a very severe and extensive gonococcal infection of the lower urinary and the greater part of the genital

tracts, or when other gonococcal complications arise such as arthritis, ophthalmia, etc. It should not be recommended for all cases of acute urethritis; the treatment is too severe for the percentage of cures in these patients who can be satisfactorily treated by less intensive methods. Intraprostatic injection of an antiseptic is another method of treatment for obstinate chronic infection. Grant has reported over five hundred cases of chronic prostatitis treated in this manner with 1 per cent mercurochrome. His injections are made through needles inserted in the perineum. Others have employed long needles used in the panendoscope for transurethral prostatic injections. Experimental work shows that the dissemination of the antiseptic is quite satisfactory and clinical reports are encouraging.

The intraurethral removal of small prostatic calculi by means of the McCarthy resectoscope is often accomplished. If the stones are small and located near the urethra, they can be dislodged after resection of the covering tissue. Other intraurethral maneuvers in the prostatic urethra, such as the opening of localized abscesses, etc., have been reported and we anticipate many advances in transurethral surgery within the next few years.

In the last decade urologists have centered their attention on the treatment of the enlarged prostate. Having established both suprapubic and perineal prostatectomy on a sound surgical basis, attention was now turned to developing technique which would give improved functional results; reduce the incidence of operative and postoperative complications; make the patient more comfortable and his convalescence shorter. In both schools this was achieved by restoring, at the time of operation, the prostatic urethra and the trigonal region to as near normal as possible. In 1924, I recall assisting Hugh Young repair the prostatic urethra and vesical neck following perineal prostatectomy; in 1926, he reported a series of one hundred cases closed in this manner. After the prostatectomy and the insertion of the urethral catheter into the bladder, sutures were taken through the vesical neck on each side and posteriorly; these were then brought out through the approximated prostatic capsule. The bleeding was controlled when these sutures were tied; the prostatic cavity was obliterated; and the posterior flap was brought up into its normal position. A perineal tube was left in place twenty-four hours for safety. In a few cases a hemostatic bag was necessary to control the bleeding; this was later withdrawn through one side of the prostatic incision. Many of these cases had no perineal urinary drainage and their postoperative convalescence was considerably shortened. Many of us have been using this technique in perineal prostatectomies during the last ten years. Winsbury-White, of London, and Wildboltz, of Bern, have reported practically the identical procedure and have attained equally encouraging results.

The suprapubic prostatectomist also has been improving his technique. In 1927, Lower presented a similar method of closure following suprapubic prostatectomy; he carried out suprapubically practically the same procedure just described. He sutured the prostatic bed to the vesical orifice; thus obliterated the prostatic cavity and controlled the hemorrhage. He then closed the bladder and drained with an urethral catheter. His report, however, did not receive favorable attention, probably because of the lack of a definite standardization of technique and the difficulty in carrying out the procedure. There was a good deal of distrust in the principles involved—first, in the complete closure of such a bladder; and second, in not controlling the hemorrhage by a pack or a rubber bag. However, in 1929, Harris, of Australia, reported in the British Journal of Surgery an exact technique and instruments developed to use in such a closure. He advocates the use of a special bladder retractor with lamps down in the bladder which give excellent vision of the vesical orifice and prostatic bed. He places two hemostatic sutures at five and seven o'clock in the vesical orifice to control the lateral arteries. He then re-forms the prostatic bed; by the use of a special boomerang needle and holder, he draws the triangular flap of trigonal tissue down into the prostatic cavity and sutures it to the posterior portion of the floor or torn edge of the prostatic urethra. He then obliterates part of the prostatic cavity by two deep anterior transverse sutures. He has thus re-formed the floor of the trigone and prostatic bed, obliterated the prostatic cavity, and controlled the bleeding. The bladder is closed tightly and drained with an urethral catheter. He reported a series of 371 cases done according to this technique, 322 one-stage and 49 two-stage prostatectomies, with a mortality of 2.7 per cent. The postoperative convalescence was greatly shortened and complications markedly diminished. Sargent, in 1931, claimed that the complicated methods of Harris and Lower were not necessary. He reported a closure by simply suturing the posterior edge of the torn capsule to the bed and taking two anterior transverse sutures. Lee-Brown, on the other hand, claims that all these closures are dangerous unless done by the expert. Those who have not cared for these more exact techniques have depended upon especially constructed hemostatic bags, such as Fullerton's which is made so as to prevent the stretching of the external sphincter and compressor urethrae muscles. Others use merely a running suture at the vesical orifice to control hemorrhage, and close the bladder around a small drainage tube. It is apparent, therefore, that in the last ten years considerable emphasis has been placed on the closure of the perineal and suprapubic wounds so as to give better functional results, prevent serious postoperative complications, and give the patient a shorter and happier convalescence.

In discussing recent advances in prostatic surgery, one must lay greatest emphasis on the transurethral approach on the enlarged pros-

tate. To review, as so many recently have, the evolution of transurethral prostatic surgery from the crude instrument of Guthrie, in 1830, to the refined armamentarium of today would be unwarranted repetition. Merely to mention the names of the men who were perhaps most instrumental in developing the idea is sufficient:

Guthrie, in 1830, with a catheter with enclosed blade;

Mercier, in 1844, with a tube with knife enclosed;

Bottini, in 1874, with a cautery blade;

Fraudenburg, in 1897, adding cystoscopic features;

Chetwood, in 1901, with the galvanocautery;

Young, in 1909, making the first real advance toward the modern instrument in adding the fenestrum to make his punch;

McCarthy, in 1918, adding a handle and an eye to the Young punch;

Stevens, in 1912, with an electrocautery for cutting the lateral lobes;

Luys, in 1914, with his "Forage de la Prostate" using a cautery knife blade;

Caulk, in 1920, with a cautery punch and advocating his inflammatory hyperplasia theory;

Collings, in 1922, with his electrotome, whittling away small pieces;

Stern, in 1926, with his resectoscope attacking lateral lobes, but handicapped because of poor vision and inadequate electric cutting and fulgurating currents;

Foley, in 1929, with his endothermal prostatic excisor, removing large lobes in one piece—mostly experimental at that time;

Day, in 1930, with his punch and diathermy needle to cook the tissue before excising it;

Davis, in 1930, who persevered with the Stern resectoscope, adding a larger loop, electromagnetic foot switch, improved light, and with improved cutting and coagulating currents brought it before the medical profession as a practical procedure;

Kirwin, in 1931, with his rotary punch;

McCarthy, again in 1931, taking the Stern-Davis instrument and fitting it in his panendoscope, making it the most efficient modern instrument;

Braasch-Bumpus, 1932, with a cold knife resectoscope, using multiple needles;

Thompson, in 1935, making a few changes in the Braasch-Bumpus punch.

To all these and perhaps others who have escaped attention is due the credit for the evolution of transurethral prostatic surgery and the development of our modern armamentarium.

Transurethral prostatic resection has come to stay; there are very definite indications for its use. The operator must be experienced with the procedure and skillful in the use of the instrument. It should be unnecessary to emphasize the dangers awaiting the careless, inexperienced instrumenteur; he who cuts before he is absolutely sure exactly what he is cutting is inviting serious trouble. The surgeon who does only an occasional resection, or attacks only small median or lateral lobes, shall not be considered a resectionist. By the competent resectionist, we refer to one who has a thorough knowledge of the use of the resectoscope; is intimately familiar with the anatomy of the vesical neck and prostatic urethra; has the highest regard for operative and postoperative sterile technique; has some knowledge of electrical currents used and their actions on the tissues encountered; is most careful,

skillful, and persevering in his operative technique, and who, beginning on small enlargements, slowly and gradually attacked larger glands; has done at least two hundred transurethral resections and is proficient in resecting the large intraurethral lateral and large median lobes. A man with these qualifications can be considered a resectionist and a suitable or capable representative to give his opinion and report his results of this operation. It is, of course, realized that one must have a beginning and it will take some time before he has done this number of cases. In justice to the operation and to the private patient, these requisites are not too stringent because transurethral prostatic resection, particularly on the large glands, is a most difficult operative procedure.

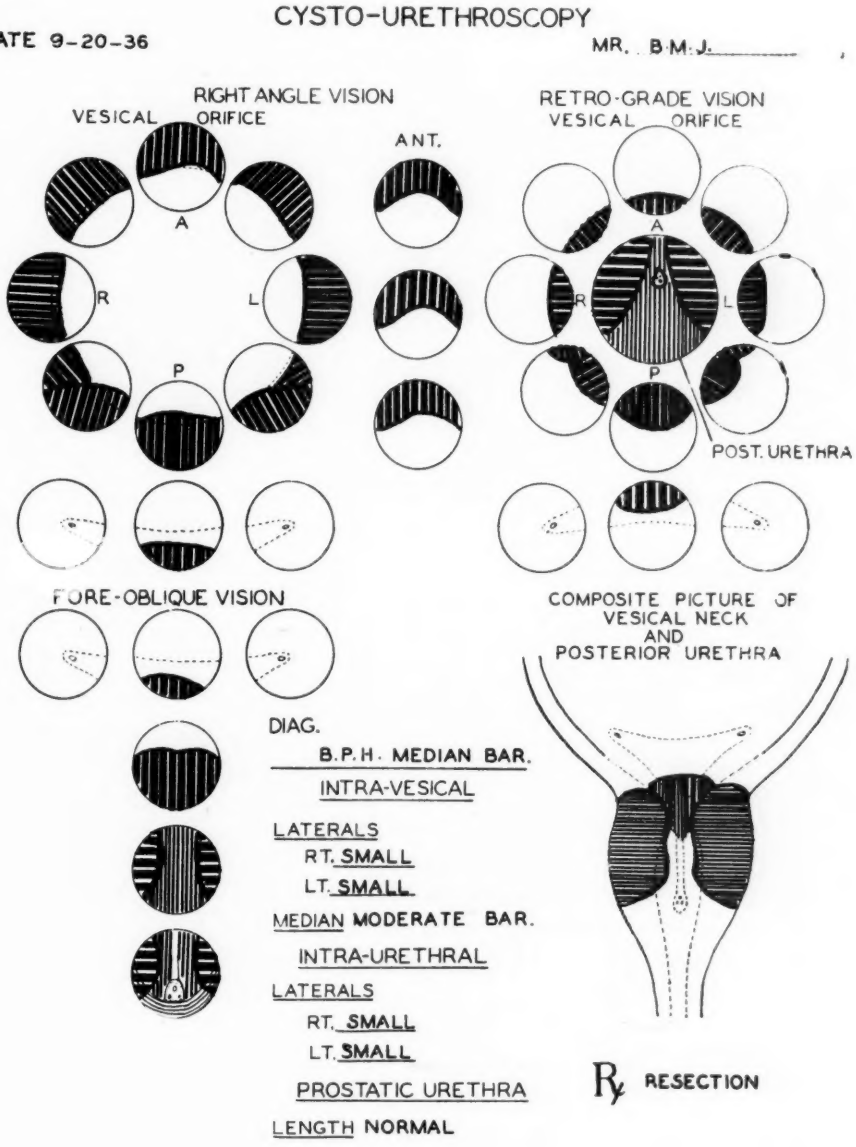
Today there are several instruments on the market for transurethral operations: the Bumpus-Thompson, Kirwin, Foley, Day, and Stern-McCarthy. We shall express no opinion on any except the Stern-McCarthy, inasmuch as practically all of our work has been done with this instrument. Considered from every angle, we believe the Stern-McCarthy resectoscope is the superior instrument, realizing full well the possible advantage of cutting with a cold knife. As to the electrosurgical units, both the Bovie and the Burdick are excellent. Space does not permit a comparison with other makes. All of these cases have been done with the Bovie Sparkgap machine and it has proved entirely satisfactory.

These patients must receive the same careful and skillful preoperative care afforded those being prepared for a prostatectomy. The use of the phthalein curve with half-hour collection periods is essential; this, together with the blood urea, gives us the best index of renal function and renal reserve power. It has, however, been proved that patients who certainly would not weather a prostatectomy may undergo a transurethral resection quite satisfactorily. This does not warrant premature operation, but it does permit us to resect some patients who would otherwise have merely a permanent cystostomy or live a catheter life. Thompson says that no drainage, or three or four days of it, is all that is necessary. He feels that the danger of complicating upper urinary tract infection is a greater risk than that of resecting before the renal function tests are optimum. Sixteen per cent of his cases had a blood urea at the time of operation of over 50 mg. per 100 c.c. A personal case in this respect is of interest. An old doctor in complete retention from extensive carcinoma of the prostate, and who had had two weeks of catheter drainage, had a blood urea consistently of 80 mg. per cent, and several repeated phthaleins showed the best curve of 5 per cent secretion in the first half-hour period and 10 per cent in the second period. He underwent transurethral resection perfectly smoothly, left the hospital in six days, able to void a satisfactory stream, and continued to empty his bladder with comfort the remaining eight months of life.

Whether a resection carries equal or perhaps less risk than a first-stage cystotomy is still an open question. At present there seems to be some dispute as to whether in uninfected cases with approximately 100 to 150 c.c. of residual urine, but with a good phthalein curve and normal urea, there should be preoperative catheter drainage. There is evidence in favor of this viewpoint. At present it is too early to say definitely; experience will be the guide in the future. Of our cases, 243 were drained with an urethral catheter, 93 had no preoperative drainage, and 5 had cystotomies because of their inability to tolerate a catheter, urethritis, urethral fever, or anticipation of a markedly prolonged drainage. The residual urine was as follows: 79 had complete retention; 21, between 500 c.c. and 1,000 c.c.; 43, between 200 c.c. and 500 c.c.; 60, between 100 c.c. and 200 c.c.; 85, between 30 c.c. and 100 c.c.; 46 had none; and in 16 the residual urine was not noted. It has been proved that whenever retention urethral catheters or repeated urethral instrumentation is carried out epididymitis will occur in from 10 to 25 per cent of the cases. This has been reported at length by the writer in the Journal of Urology, 1928. A bilateral vasectomy should always be done as soon as the patient has decided to have treatment; this is usually before any urethral manipulation. Hence in our cases there has been no postoperative epididymitis. In the 20 cases in which the vasa were for some reason not ligated, epididymitis occurred in 3.

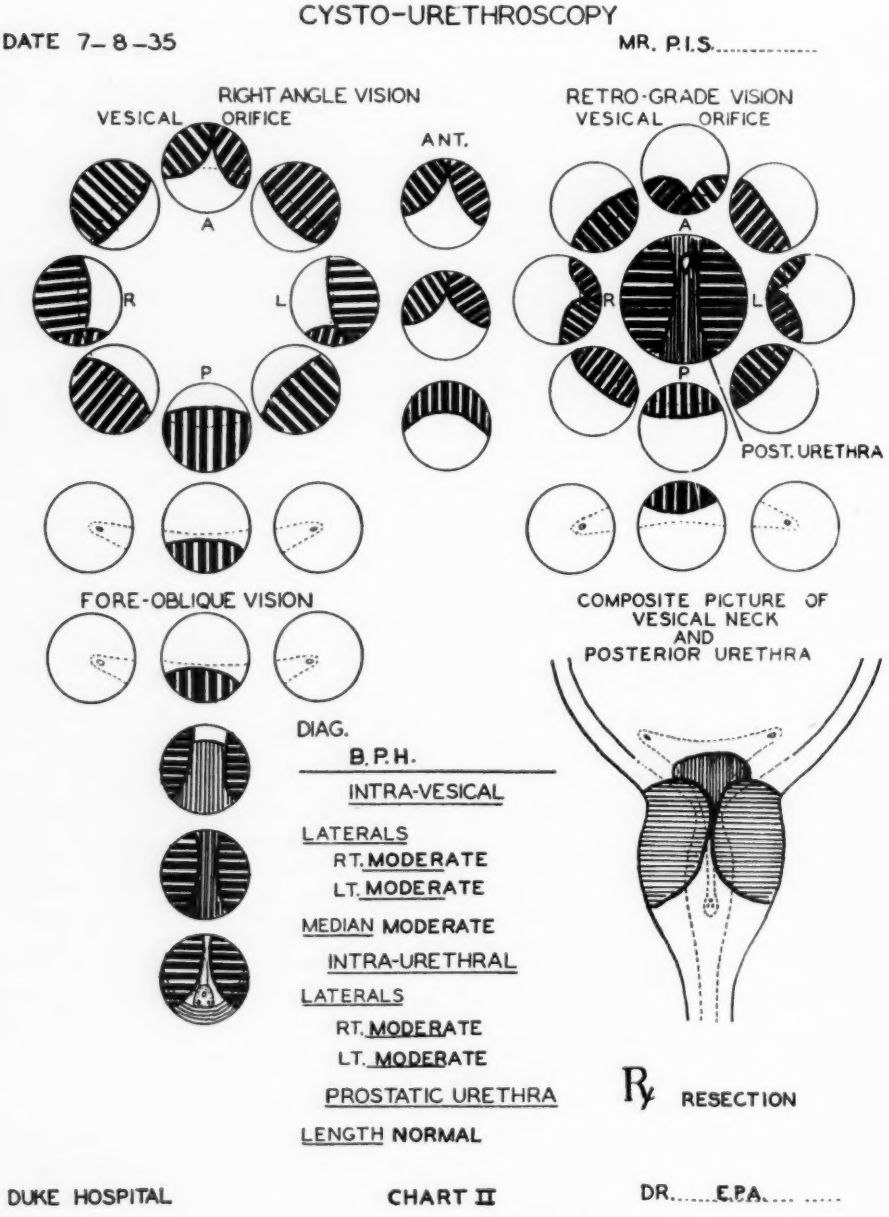
At present, probably the greatest difference of opinions among urologists is in the selection of cases suitable for transurethral resection. There are those who feel that only contractures of the vesical orifice, median bars, small median lobes, and carcinoma are suitable for this procedure. This group shown in Charts I and II includes probably 5 to 10 per cent of all obstructions. A second group would add the moderately enlarged intraurethral lateral lobes and large median lobes (Chart III); this raises the proportion to about 50 per cent. A third group would include the large median lobes and the large, elongated intraurethral lateral lobes and a combination of these two (Charts IV and V), raising the percentage to 75 or 85 of all cases. Finally, there is a fourth group in which belong Kretschmer, Alcock, Davis, Thompson, and others who believe that this operation is the one of choice in any case in which the resectoscope can be passed. In the last three years, we have done 82 per cent of our prostatic obstruction cases by the transurethral method. Randall's classification of the five different types of prostatic hypertrophy seen in the human is instructive. The first is a simple hypertrophy of bilateral lobes, all of which is extravesical and consists of the large intraurethral lateral lobes (Chart V). This is one of the hardest types to resect; it is the soft, bleeding gland. In some cases, depending upon the size, it may still be an open question

whether or not this is a type suitable for resection. In these cases some advise a preliminary fulguration of the surface. The second type is a solitary commissural hypertrophy and postcommissural enlargement



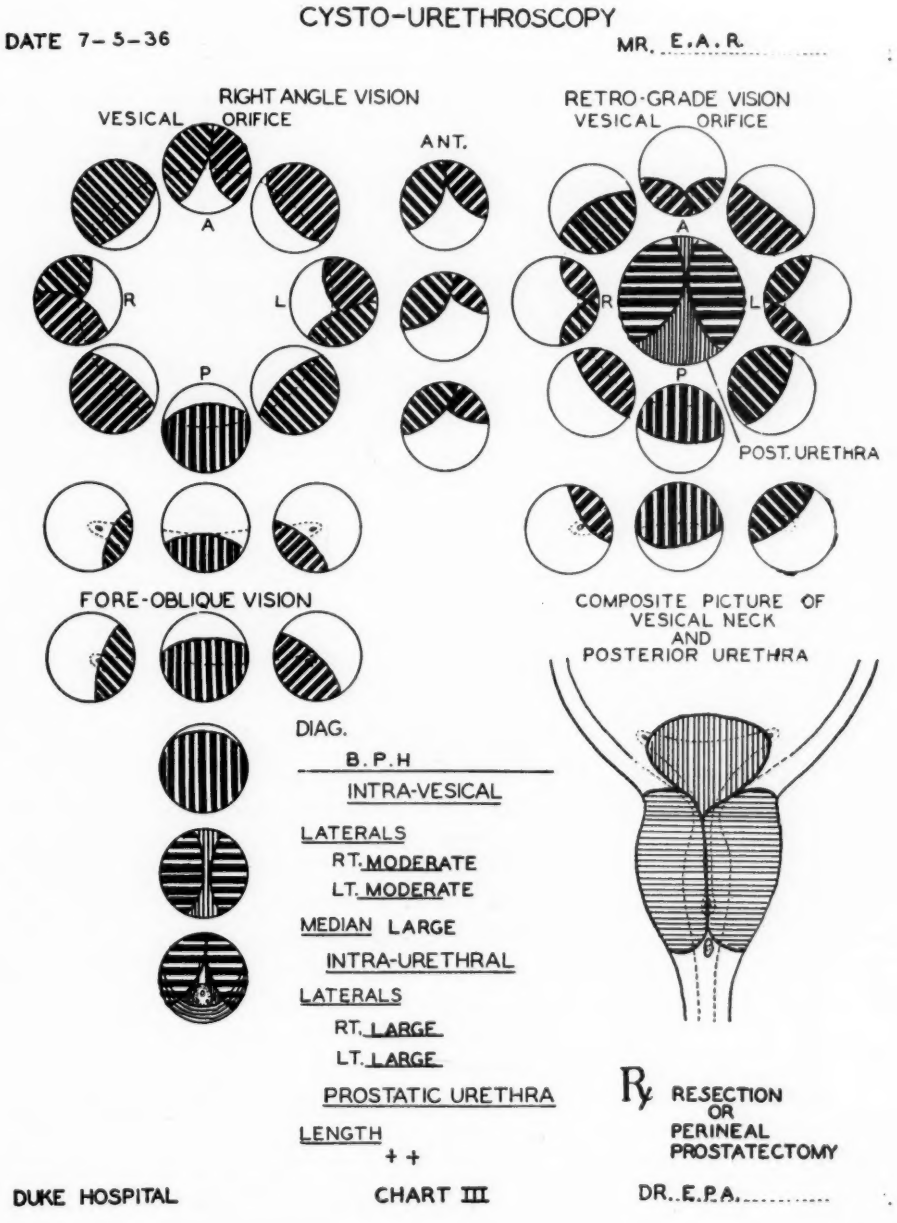
with obstruction to the trigonal muscle causing hypertrophy and bar formation (Chart I). The third is a continuation of the second with the commissural hypertrophy causing a sphincteric dilatation and the lateral lobes then protrude into the bladder. The fourth is a subcervical gland of Albarran, the median lobe type (Chart IV); and the fifth, the sub-

cervical and laterals together producing huge growths of both lateral and median lobes (Chart III). To all of these types resection is applicable, unless perhaps in the first or fifth groups when they are so large



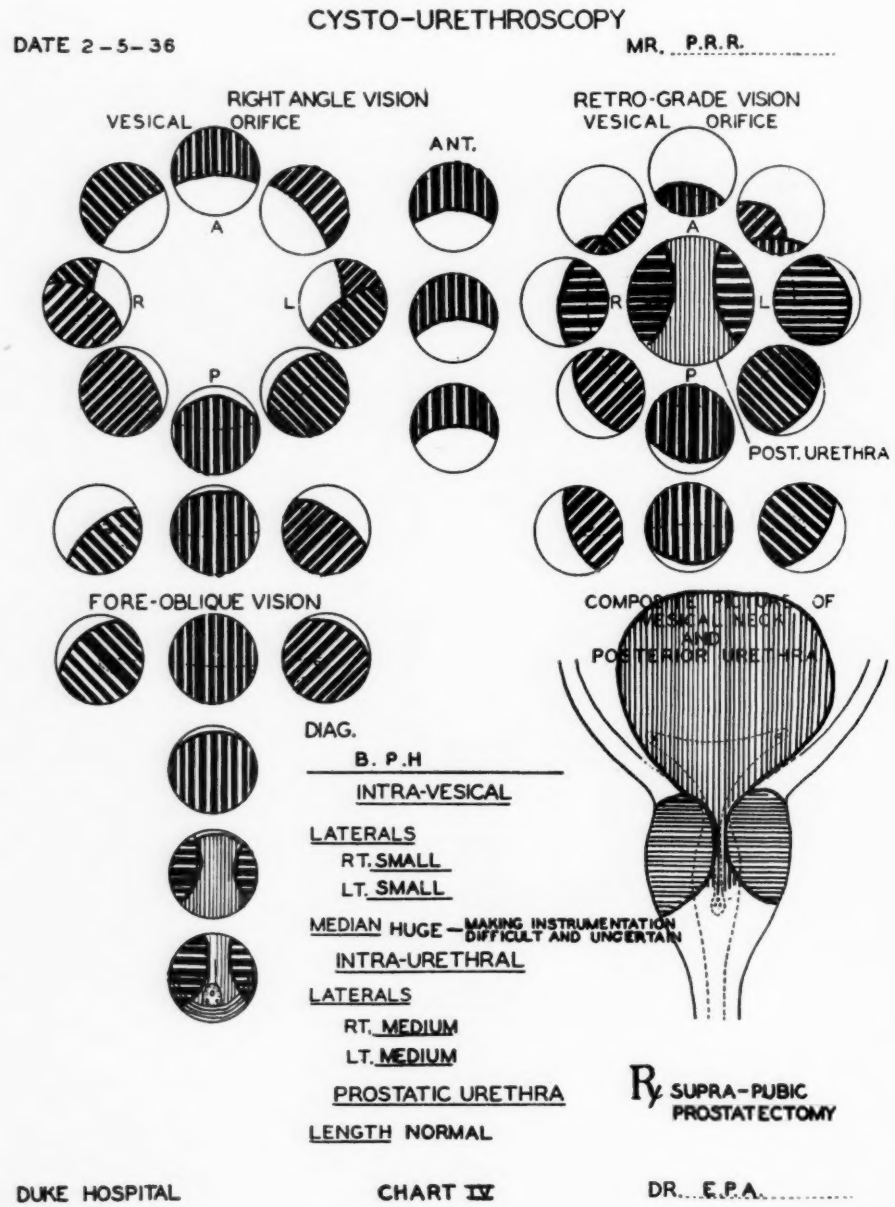
that the space between the gland and the bladder wall is so small that vision is poor and the danger of operative error great; or when the instrument cannot be inserted. Other contraindications for the operation are a large stone in the bladder; a huge median lobe, which could very easily be enucleated suprapubically and would be very difficult

transurethrally. All other cases, which comprise about 80 per cent tc 90 per cent, are applicable to resection, provided as stated above the operator has had the proper experience.



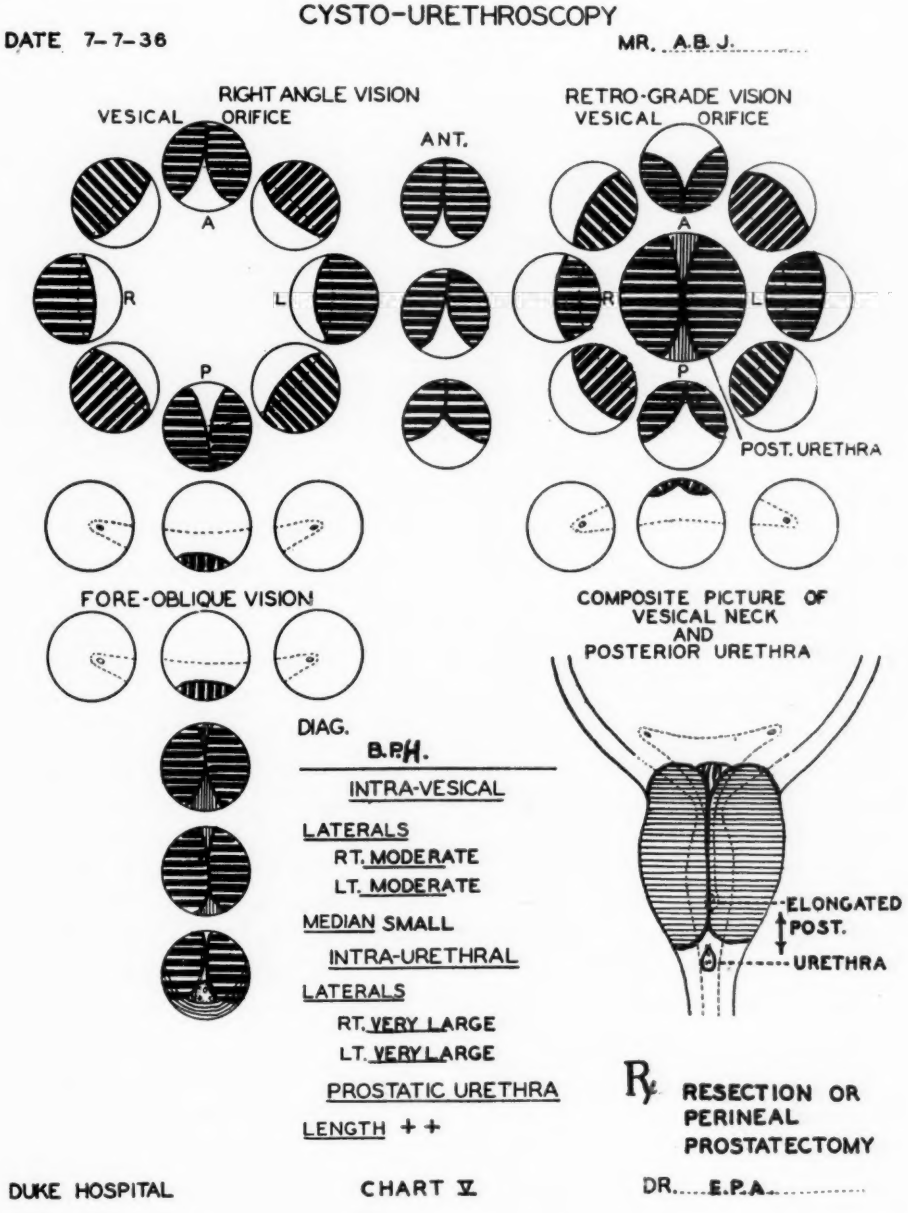
It has been only in the last five years that this operation has been employed on a large scale by some of the best urologists in the country. It is, therefore, too early to state dogmatically just what are its limits of possibility. An opinion, however, can be given; it can be stated emphatically that the beginner should attack only the median bars, con-

tractures of the vesical orifice, and small median lobes. Only after fifty or more of these cases have been done and a careful, skillful technique developed should intraurethral lateral lobes and the larger glands



be attempted. The good urologist will not think he has become proficient in this operative technique until he has done at least two hundred or more resections on all types of glands. Even then in some of the larger cases he will wish for more skill and experience. It is unfair for him to report a series of less than two hundred and fifty cases or

to feel that he can pass judgment on this operation unless he has had at least this, and preferably more, experience in all the different types of cases, and particularly in the larger ones. Resection of the large



glands is one of the most difficult urological operations. On the other hand, operation on the small bar is one of the easiest. For the former type is required the most careful attention to a multitude of details, patience, skill in the actual performance, and the most meticulous post-operative care. This, together with large experience, is essential for

good results; the greater the experience of the operator, the greater the usefulness of the instrument.

A preoperative plain x-ray of the kidneys, ureters, and bladder and an air-cystogram are always made. This gives definite information concerning stones, diverticula, contracture, character and position of the bladder in the pelvis, and other data. Except in cases where diagnosis is uncertain, cystoscopic examination is not carried out until the patient is ready for his resection. At this time the patient is given either a caudal or a low spinal anesthesia. Either is quite satisfactory. Wishard and Frischer have recommended using local anesthesia, injecting it through a long needle which fits in the resectoscope. We have had no experience with this method. Under the anesthesia a very careful examination of the bladder, vesical neck, and prostatic urethra is made, using the right angle, retrograde, and foreoblique telescopes. An accurate impression of the exact pathologic anatomy cannot be obtained in any other manner. We feel that the various methods of cystourethrography are interesting but unnecessary and certainly inferior to direct observation. The views made with the three telescopes and the composite picture are recorded at the end of the operation on special cystourethroscopic charts. This gives a permanent record of the exact preoperative pathologic anatomy.

The charts shown here represent five of the various types that are frequently encountered. Chart I shows the different telescopic views of the small median bar formation. Chart II shows the moderately enlarged median lobe together with moderate enlargement of the intraurethral laterals. Chart III represents the large long intraurethral lateral lobes with a large intravesical median—this is a type which we may in the future decide to do perineally. Chart IV shows the tremendous intravesical median lobe. This is most easily enucleated suprapubically. Finally, Chart V shows the markedly elongated intraurethral lateral lobes with intravesical protrusion. This type, by many, is thought best treated by perineal prostatectomy. With this mental picture of the pathologic anatomy of the vesical neck and the prostatic urethra, we are ready for the reconstruction.

The clean-up technique for this procedure must be just as careful as for an intraabdominal operation. In most clinics this phase of the operation is neglected and it may account for many of the postoperative elevations in temperature reported. The resection is then carried out in the usual manner; first, the intravesical median lobe; then the intravesical laterals; and finally, the intraurethral lateral lobes are resected. One side is completed before the other is attacked. Care should be taken that all bleeders are coagulated at the time of the cut and all pieces of tissue removed. By this technique the situation is entirely under control at all times. Space does not permit a minute descrip-

tion of the exact surgical technique. When the operation is completed, there is an open channel from the verumontanum to the trigone, with the greatest excavation just distal to the vesical sphincter. The criterion we like to use is to be able to see into the bladder from two o'clock around to ten o'clock using the right angle telescope at the level of the verumontanum. Sufficient tissue has always been resected when this is possible.

The exact technique of the operation with various instruments cannot be explained here in detail. One should mention, however, the Thompson resectoscope. This is a cold knife punch instrument based on the Braasch-Bumpus punch; excision is followed by fulguration of the bleeding points. In the hands of the expert familiar with this instrument, the reported results are excellent. Foley has devised an instrument which is applicable in certain cases with large intravesical protrusions. He has removed very large intravesical lobes in one or two pieces and then broken them up in the bladder before removal. The punch instruments of Kirwin, Day, etc., have been described. Ballenger has suggested in the very large intravesical type it might be advisable to remove the intravesical enlargement with the electrosurgical loop through a suprapubic incision, and then relieve the intraurethral obstruction transurethrally. This would depend entirely on the size of the intravesical enlargement and the skill of the operator as a transurethral surgeon.

There are conflicting reports as to the amount of hemorrhage encountered at the time of operation. This depends upon the experience of the operator and the type of gland. With the use of the Davis-Bovie electrical unit, we have never had any serious difficulty in stopping the bleeding. Although all types of cases have been operated upon with blood pressures ranging as high as 250 mm., it has always been possible to control the hemorrhage in our patients and to have the drainage clear at the end of the operation. Eighty per cent of our cases are perfectly clear within twenty-four hours, and 98 per cent within forty-eight hours postoperative. In this series of 350 cases, postoperative fulguration was carried out for primary hemorrhage in three; none have been necessary in the last two years; none for secondary hemorrhage; and one for late secondary hemorrhage, two months postoperative. The number of cystotomies for hemorrhage within the first three days, none; within the first week, one (this was an early case done four years ago); and over a month, none. These statistics show that there is complete control of hemorrhage at the time of operation in all cases and that secondary hemorrhage is negligible. There have been no cases of incontinence at the time of discharge. Patients may complain of a little urgency and dysuria for a few days after the removal of the catheter, but this clears up and in no case has the external sphincter been injured. If the proper care is taken at the time of operation, the

sphincter should never be harmed. The only possible instance in which this complication might be justified would be in an extensive carcinoma in which the verumontanum and external sphincters are so invaded by the neoplasm as to make their identification impossible. We have not as yet encountered a case in which some identifying structure in this region could not be recognized.

The literature is full of many varieties of operative complications. Many ruptured bladders are reported. This is usually due to overdistention with fluid, or cutting through the wall in the region of the trigone or vesical orifice. Extravasation of urine is another error due to faulty cuts. Uncontrolled hemorrhage, postoperative incontinence, and other complications are cited. Rupture of the bladder due to the ignition of an explosive mixture has been reported; it is now known that the gas formed in the bladder is explosive only when mixed with oxygen or air. Hence this complication will be prevented by forcing no air into the bladder with a syringe and being positive that the spark always occurs under the fluid. All of these complications are admittedly due to either carelessness or faulty technique of the operator and will be remedied with the increasing experience of conscientious surgeons. Such incidents again emphasize our contention as to the requisites of an expert resectionist.

The prevention of infection in the urinary tract is most important. Many of these patients already have an infection, but new infections should not be superimposed. Since 1930 we have been using a special irrigation apparatus which is connected to the catheter as soon as it is inserted. This is done always by the doctor. The irrigation of the bladder can then be made by the nurse as often as desired without disconnecting the end of the catheter from the irrigator. This will eliminate the infection caused by faulty irrigations by orderlies, nurses, etc. Frequent irrigations are used, varying from every half-hour to every two hours, so long as there is any blood in the drainage. After it is clear, the bladder is irrigated routinely every four hours. A survey of our charts shows that there was no elevation of temperature in 101 cases, an elevation between 37.5° and 38.5° in 153 cases, between 38.5° and 39.5° in 79 cases, and between 39.5° and 40° in 14 cases. The average duration of elevation was three days. There were 167 patients who had no elevation at all after the second postoperative day. This shows remarkably slight postoperative elevation of temperature. The care and method of irrigation may be largely responsible for this.

The period of hospitalization has been markedly reduced by this type of operation. In this series the average number of postoperative days was nine; Bumpus in the Mayo Clinic averaged also nine days; and Kretschmer in 551 cases reports an average of 9.1 postoperative days. The convalescence is without doubt much easier for the patient; he is up in the chair and perfectly comfortable the day after operation.

Hence, postoperative pulmonary and cardiovascular complications should be reduced. The urethral catheter is removed in from twenty-four to seventy-two hours with an average of forty-eight hours, depending upon the amount of tissue resected.

Objection has been raised that sometimes the obstruction is so large that more than one operation is necessary for the removal of all the obstructing tissue. This is not a valid objection to the procedure; the operation causes no surgical shock and such slight discomfort to the patient that even if two or three resections are necessary they are withstood better than a prostatectomy. Operation must be repeated until all the obstructing tissue has been removed. It is not advisable to continue the operation for a longer period of time than one or one and one-half hours. After one and one-half hours the anesthesia usually begins to wear off; there is bladder discomfort on distention; there is some fatigue to the patient in prolonged operation; the continued urethral trauma and the loss of efficiency in the operator after this length of time must be remembered. These are all things to be considered. There is usually no contraindication to a second operation in five days, provided the patient has no elevation of temperature. If, after the catheter is removed, the patient is not voiding as freely as he should; his stream is not as large or as forceful as it should be; frequency is marked; the individual voidings are not over 100 c.c. or signs of residual urine are present, one should not hesitate to repeat the resection as further obstruction is most probably present. One exception to this is when postoperative edema or inflammation is responsible for the obstruction. In such a case the catheter is replaced for a couple of days. The more proficient one becomes in the operation, the fewer second and third resections will be required. In the first 100 resections, 7 malignant and 3 benign cases had a second operation; in the second hundred series, 4 carcinomas and 3 benign cases were repeated; in the last 150 patients, only in 1 carcinoma and 1 benign case was a second resection required. This emphasizes again our contention concerning the necessity of operative experience.

Inasmuch as the whole tumor is not removed by a resection the question of recurrence quite naturally arises. One might be justified in believing that it would be more frequent after resection than after prostatectomy but this does not seem to be true. It is well known and has been brought to our attention recently by several writers that after prostatectomy, either suprapubic or perineal, there is a certain definite percentage of recurrences. Just how high this is, is difficult to state, because the patients with recurrence rarely return to the clinic of operation. Certainly this same percentage is expected after resection; the question is, will it be higher? This cannot honestly be answered at present. However, it can be said that, in the cases that have had adequate resection, recurrence is exceedingly rare and apparently no

higher than that of other operative techniques. Thompson reports a recurrence of 49 in a series of 1,194: 16, carcinoma; 10, median bar; and 23, benign hypertrophy. He thinks that it is due to (*a*) a nodular cleft projecting into the vesical neck or posterior urethra; (*b*) an uncut lateral, intraurethral lobe that falls into the urethra after the median has been removed; (*c*) postoperative temporary inflammation; (*d*) pieces left in the bladder; (*e*) median lobes not entirely removed; (*f*) atony of the bladder wall. Certainly these causes are all of faulty operative technique and not true obstructive recurrence. Davis in his series of 748 resections reports 46 patients who had had a prostatectomy previously. In his series he had 24 recurrences in the first six months: 9, benign, which he claims were not at first completely resected; 8, carcinoma; and only 7, true benign recurrences. In this series we had 6 cases: 4, carcinoma, and 2 benign; 1 was two months postoperative and the other, one month. We are convinced that these are cases in which sufficient obstructing tissue was not removed and are not, therefore, true recurrences. Time alone will tell the relative frequency of recurrence in this operation; it is far too early at present to give statistics of any value on this point. However, from the records at hand, it can be said that recurrence within the first five years is no greater than after prostatectomy.

Mortality statistics in prostatic surgery are always most interesting and important. In this series of 350 cases, the mortality was 1.7 per cent in personal cases and 2 per cent in personal cases plus the few done by the resident urologist. Table I gives a summary of the deaths with the age, complications, the size of the gland, the cardiovascular condition, the preoperative blood urea and renal function, and the postoperative complications. In only one, No. 52154, do we feel that death was directly dependent upon the type of operation. In that case, the bulbous urethra was probably ruptured when passing the urethral sounds, in preparation for the introduction of the resectoscope. It will be noticed that one case in the series died from uremia, most likely due to an acute pyelonephritis. We have been fortunate in this respect for, although the greatest skill and care is exercised, a certain percentage of patients with prostatic hypertrophy will die from pyelonephritis no matter what type of operation is performed. We like to feel that this low mortality rate is due to the meticulous care taken in treating these patients before, during, and after operation. This mortality compares favorably with that of other clinics: Davis reports a mortality of 0.8 per cent in 748 cases; Thompson, 0.3 per cent in 630 cases; Alcock, 1.4 per cent in 500 cases; Kretschmer, 3.2 per cent in 551 cases. These mortality rates are certainly lower than those of either suprapubic or perineal prostatectomy; furthermore, many of these patients have been resected who would not have been operated upon, because of their poor surgical risk, if they were to have had a prostatectomy.

TABLE I

CASE	AGE	SIZE OF GLAND	CARDIOVASCULAR CONDITION	RENAL B. U.	FUNCTION PHTH.	P. O. COMPLICATIONS
No. 10634	71	B. P. H. with moderate symmetrical enlargement; 10 gm. removed.	Gen. arteriosclerosis with arteriosclerotic heart disease and hypertension.	84 mg.	App. 10 14% 10% 5% 4%	Died 30 days in uremia with B. U. of 206. Renal failure. Normal temperature.
No. 29292	57	B. P. H. Small median lobe. Only 3 gm. removed.	Generalized arteriosclerosis with hypertension. B. P. went to 340 mm. at operation. Caudal anesthesia.	48 mg.	App. 8 35% 20% 12% 5%	Died 6 days. Cerebral embolism and pneumonia.
No. 52154	76	B. P. H. Small median lobe and mod. enl. lat. intraurethrals.	Generalized arteriosclerosis.	28 mg.	App. 10 20% 20% 13% 5%	Died 11 days. Pneumonia. Perineal abscess.
No. 55148	71	B. P. H. Intraurethrals and small intravesical median lobe; 14 gm. removed.	Generalized arteriosclerosis with mild hypertension.	46 mg.	App. 8 20% 30% 10% 5%	Died 3 days of atelectasis of right lung.
No. 61279	69	B. P. H. of small, fibrous type; 3 gm. removed.	Generalized arteriosclerosis with hypertension.	32 mg.	App. 5 40% 15% 5% 7%	Died 13 days of pneumonia.
No. 62408	70	B. P. H. Large intraurethral laterals and mod. median lobe. Only 7 gm. removed.	Generalized arteriosclerosis.	44 mg.	App. 5 30% 25% 7% 5%	Died 10 days in uremia with pyelonephritis (B. U. 180).
No. 64904	60	B. P. H. Small intravesical median. Very large intraurethral lateral lobes.	Generalized arteriosclerosis with hypertension.	32 mg.	App. 5 35% 20% 7% 3%	Died 1 day of pulmonary embolism.

Treatment of the enlarged prostate is ever in the mind of the urologist. It is a live and active subject. Continued change and advance has been the rule in the past fifty years. It will continue as long as there are alert and active minds working in urology. The storm through which we are now passing seems tempestuous, but in the calm which inevitably follows, the truth will stand and be gladly accepted. Just what this will be, no one can now say. There is certainly much in favor of the newer ideas. How far they can be carried is a question for the future to answer. Hugh Cabot puts it quite fairly: "It is perhaps safe to guess that suprapubic prostatectomy will long hold a place where expert urologists are not available. Perineal prostatectomy will have to fight it out with transurethral resection. Both of the operations require prolonged training, great skill and dexterity, and large experience. Given these in equal measure, I suspect that the younger generation, armed with better equipment, will win the day for transurethral operations." This is a fair judgment of the controversy as it stands today.

Since the advent of transurethral resection, various techniques have been developed and reported. One of them is spoken of as shrinkage of the prostate. Smith, Stockwell, and others suggest passing the roller-type electrode over the intraurethral surface of the gland in parallel lines. This, they claim, often causes sufficient shrinkage of the obstructing portion to render unnecessary a future resection. In other cases it causes a thrombosis or occlusion of the vessels so that a subsequent resection is made easier; the bleeding is less and the postoperative reaction, the temperature, etc., are distinctly diminished. They suggest this in all cases that are too poor risks for a complete transurethral resection. It is too early and we are too inexperienced in this method to give an opinion. It will take many years before the true value of this procedure is established.

Along with these radical changes in the treatment of the enlarged prostate, there have been certain groups working on the problem from an entirely different angle. Lower, Deming, and others have been carrying out experimental work in the endocrinology of the prostate. It has, of course, long been known that castration sometimes relieves prostatic obstruction. It is now known that castration may cause a diminution in the size of glandular structures in the true prostatic tissue, but that the hypertrophied tubules are not affected in any way. Lower has shown the hypophyseal-gonadal influence on the growth and development of the prostate gland and feels that clinically he has relieved many cases of obstruction by the injection of a substance called inhibin. This is the name given to a hormone secreted by the testes which depresses the gonadotropic activity of the pituitary gland. Howard states that experimental evidence shows that inhibin elaborated by the tubular cells of the testes is diminished in amount as the age of the individual advances and

the spermatogenic function declines. With the restraint removed, the pituitary becomes hyperactive and stimulates the interstitial cells to elaborate an excess of androtin which in turn acts upon the prostate to produce enlargement. This being true, it seems rational to treat prostatic hypertrophy by the administration of the hormone inhibin. Lower selected for his experiments the soft adenomatous type gland, as he thought they should respond better to this kind of treatment. In the clinical analysis of forty cases, they consider 65 per cent markedly improved to the point where they were virtually symptom free; 35 per cent showed no improvement at all and they could find no consistent factor to explain the failure in these cases. It may have been due to the fact pointed out by Deming that the suburethral glands are not controlled by the endocrine system. Paul Niehans reports senile changes in the prostate due to the removal of the inhibiting action of the hormone secreted by the seminiferous tubule. This is due to the unrestrained action of the secretion of (*a*) interstitial cells of Leydig, (*b*) secretion of basophil cells of the pituitary gland, and (*c*) the female hormone known to be present in man as well as in woman. Since 1927 he claims to have relieved 400 cases of prostatic hypertrophy by interepididymotesticular ligature, and with marked rejuvenating effect. He postulates by occluding the afferent ducts of the testis; the hormones of the germinal epithelium are forced into the circulation and inhibit the action of the secretion responsible for senile changes in the prostate. Something, no doubt, will come out of the extensive experimental work being done on the endocrinology of the prostate as well as on other glands of the body. However, from the knowledge at hand, we are not yet justified in applying it clinically in benign prostatic hypertrophy.

Recently a rather fantastic report came from E. Payer in Germany. He claimed that by the injection of four to six doses of Pepsin-Pregl solution, spaced two or three days apart, he has restored free voiding to 68 per cent of his patients with prostatic hypertrophy; that the 30 per cent failures had been due to either carcinoma of the prostate or to technical errors. However, no cases are described and no details given, so it can receive no serious attention.

There still remains for consideration the subject of the treatment of carcinoma of the prostate. The recent works of Rich, Moore, and others show conclusively that it is far more prevalent than was ever believed. They have reported that from 14 to 20 per cent of all men over fifty years of age show carcinomatous degeneration of some of the tubules in the prostate. This was determined by cutting the whole prostate in serial sections. Most of these men fortunately do not show any clinical evidence of the disease. Nevertheless, they have small areas of malignancy hidden away somewhere in the gland. Not so many years ago Mayo truthfully said: "No matter what one does for malignancy of the prostate he does the wrong thing." While this was true at that time,

it certainly is not so today. We can do much to help the patient, prolong his life, relieve him of his obstructive symptoms, and ease the terrific pain caused by metastasis. Only a small percentage of these cases come to the urologist sufficiently early to have the radical operation performed. Young reports about forty cases in approximately twenty-five years, during which time he has seen several thousand prostatic hypertrophies. If the tumor has not broken outside the capsule and is in a localized area, this is certainly the operation of choice. In the vast majority of cases the growth has invaded the capsule, the tissues surrounding the prostate, the seminal vesicles, the base of the bladder, and the pelvic glands. To these we can offer relief of their obstruction and their metastatic pain. If the obstruction is mild, extensive radiation either by suprapubic implantation, as suggested by Barringer, or perineal implantation at open operation, or closed perineal implantation of radon seeds can be carried out. We prefer the closed perineal implantation, as sufficient radiation can be given in this manner and it can be repeated as often as one deems advisable. X-rays have been taken after the implantation of these seeds and they are found to be fairly accurately placed throughout the involved region. In addition to this the patient should receive extensive deep x-ray therapy, preferably with the 400,000 volt machine. In many cases this alone will so shrink and soften the involved prostate that it will be difficult by rectal examination to distinguish it from a chronic inflammatory condition. This has been noted repeatedly. It is not, however, always true and in many cases one will have to resort to transurethral resection to relieve the obstruction. If transurethral resection had no other value, the amount of comfort it affords these malignant cases is sufficient to claim it as the greatest advance in prostatic surgery in the last twenty-five years. These patients, who previously had to be subjected to either a rather extensive perineal operation or a suprapubic drainage tube for the rest of their lives, now can be relieved of their obstruction by a rather simple procedure. Resection can be carried out in these cases even when we are unable to get the patient in a so-called satisfactory shape for a prostatectomy. We remember an old man with complete retention from carcinoma of the prostate who had a blood urea of 95 mg. and a very poor phthalein curve. After catheter drainage for three weeks, his curve showed only 5 per cent of the phthalein excreted in the first half-hour period; 10 per cent, in the second; 5 per cent, in the third; and 5 per cent, in the fourth. This old doctor insisted upon operation in spite of his unsatisfactory condition. The resection was easily carried out and he left the hospital within a week, able to void a large stream and quite comfortable. During hospitalization he had received also a course of deep x-ray therapy over the lumbar spine; this entirely relieved the terrific pain he had been having from his metastases. For the next nine months of his life he was quite comfortable, as far as his urinary stream

and the pain from his metastatic bone lesions were concerned. Deep x-ray therapy, perineal implantation of radon seeds, and transurethral resection should be combined if necessary. This will, in the vast majority of cases, guarantee free voiding as long as they live and relief of pain. Curiously enough, cases of carcinoma of the prostate are easier to resect, as a rule, than benign hypertrophy. The tissue is firmer; it takes the loop better; and the bleeding is much less. Deep x-ray therapy over the lumbar spine, sacral region, and pelvis is given for metastatic pain. If this does not relieve the suffering, a subarachnoid injection of absolute alcohol is given; a few minims usually give immediate and permanent relief. If the patient still has excruciating pain, one must resort to transection of the sensory tract of the spinal chord—a delicate operation and one which should be done only by an experienced neurologic surgeon. Fortunately this is rarely necessary, as deep x-ray therapy takes care of the vast majority of cases. It is evident, therefore, from the standpoints of retarding the growth, of the relief of obstruction, and of easing the metastatic pain in carcinoma of the prostate, that much can be done to help this unfortunate patient.

Surgery of the prostate is, and has been for the last thirty years, a very active and constantly advancing science. In no branch of surgery in the last decade have there been such radical changes or such remarkable advances as in the surgery of the prostate. At present transurethral surgery is only in its infancy; with the steady advancement in instrumental and electrical armamentarium we may look forward to further and perhaps even more radical changes in this branch of urology. Investigation in the relationship between endocrinology and the prostate has just begun and opens up vast possibilities. Great as these advances in prostatic surgery have been in the recent past, we anticipate even greater changes in the future.

REFERENCES

Alcock, N. G.: Prostatic Hypertrophy, J. A. M. A. **104**: 734-738, 1935.

Alyea, E. P.: Vaso-Ligation a Preventive of Epididymitis Before and After Prostatectomy, J. Urol. **19**: 65, 1928.

Alyea, E. P.: Pulmonary Embolism Following Urological Surgery, J. South. Med. Assn., Aug., 1929, Vol. XXII, No. 8.

Alyea, E. P., and Andrus, E. C.: The Circulatory Complications of Prostatectomy, Surg., Gynec. & Obst. **50**: 864, 1930.

Alyea, E. P.: Renal Function Tests, Virginia M. Monthly **60**: 340, 1933.

Ballenger, E. G., Elder, O. F., and McDonald, H. P.: Two-Way Resection of Very Large Prostates, J. Urol. **30**: 531, 1933.

Barringer, B. S.: Prostatic Carcinoma, J. Urol. **33**: 616-620, 1935.

Davis, T. M.: Transurethral Prostatic Resection With Report of 748 Cases, South. M. J. **28**: 693-700, 1935.

Deming, C. L.: Further Studies in the Endocrinological Relationships of Prostatic Hypertrophy, J. Urol. **34**: 678-685, 1935.

Foley, F. E. B.: Cystoscopic Prostatectomy, J. Urol. **30**: 501-523, 1933.

Frischer, J.: Local Anesthesia in Transurethral Electrosurgery of Prostate, Urol. & Cut. Rev. **38**: 152-162, 1934.

Fullerton, A.: Uroselectan in Case of Transplantation of Ureters, Brit. J. Urol. **3**: 166-172, 1931.

Harris, S. H.: Suprapubic Prostatectomy With Closure, Brit. J. Urol. **1**: 285-295, 1929.

Harris, S. H.: Prostatectomy With Closure: Five Years' Experience, Brit. J. Surg. **21**: 434-452, 1934.

Kirwin, T. J.: The Treatment of Prostatic Hypertrophy by a New "Shrinkage" Method, J. Urol. **32**: 481-494, 1934.

Kretschmer, H. L.: Transurethral Prostatic Resection With Report of 551 Resections, South. M. J. **28**: 197-205, 1935.

Lee-Brown, R. K.: Primary Closure in Prostatectomy, Australian & New Zealand J. Surg. **2**: 339-347, 1933.

Lower, W. E., and Hicken, N. F.: An Experimental Research by Parabiosis, Showing the Hypophyseal-Gonadal Influence on the Growth and Development of the Prostate Gland, J. Urol. **28**: 601-606, 1932.

Lower, W. E., Engel, and McCullagh: A Summary of an Experimental Research on the Control of Benign Prostatic Hypertrophy and a Preliminary Clinical Report, J. Urol. **34**: 670-677, 1935.

Luys, G.: Endoscopic Surgery of the Vesical Orifice, Urol. & Cut. Rev. **37**: 34-44, 1933.

Morson, A. C., and Semple, J. E.: Study of Craftsmanship of Harris Technique for Prostatectomy, Brit. J. Urol. **6**: 207-219, 1934.

Niehans, P.: Modern Views on Hypertrophy of Prostate, Lancet **1**: 307-311, 1936.

Sargent, J. C.: Suture of the Prostatic Capsule After Prostatectomy and Primary Closure of the Bladder, J. Urol. **26**: 639, 1931.

Shaw, E. C.: A Study of the Curve of Elimination of Phenolsulphonphthalein by the Normal and Diseased Kidneys, J. Urol. **13**: 575, 1925.

Smith and Stockwell: Preliminary Shrinkage of the Prostate in Transurethral Resection, Together With a Histological Study of the Action of the Coagulating and Cutting Currents, J. Urol. **34**: 31-42, 1935.

Thompson, G. J.: Recurrence of Urinary Obstruction Following Transurethral Prostatic Resection, J. Urol. **34**: 405-416, 1935.

Thompson, G. J.: Transurethral Resection of the Large Prostate, J. Urol. **36**: 43-56, 1936.

Wishard, W. N., Jr., Hamer, H. G., and Mertz, H. O.: Local Infiltration Anesthesia of Prostate Preliminary to Resection, J. A. M. A. **102**: 32-35, 1934.

Review of Recent Meetings

A REPORT OF SOME PAPERS PRESENTED AT THE MEMPHIS MEETING OF THE AMERICAN PHYSIOLOGICAL SOCIETY

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AMONG the many papers of interest presented at these meetings, only a few can be reported in this brief summary, which will deal largely with those papers having special importance to surgery.

A number of papers had to do with the effects of anesthetics. **Marion Fay** and several collaborators reported observations on the concentration of blood constituents in dogs before, during, and after ether anesthesia. The electrocardiogram, blood pressure, and temperature were also studied in relation to the effect of one hour of ether anesthesia. They found that the blood sugar, lactic acid, inorganic phosphate, hemoglobin, and red cell count showed consistent increases during anesthesia, while potassium, pH, CO_2 combining power, and water content decreased. Moderate decreases in blood pressure and temperature also occurred. There was a marked increase in heart rate. No significant changes occurred in nonprotein nitrogen, fibrinogen, albumin, globulin, chloride, total base, or in the white cell count. These studies appear to be the most comprehensive of any that have been undertaken to investigate the whole picture of changes occurring under anesthesia.

F. F. McAllister, working at the University of Maryland, reported studies on the effect of ether anesthesia upon the plasma volume of dogs, using the blue dye T-1824 and determining it by spectrophotometry. He found that etherization of from one to two hours reduced the plasma volume in fourteen experiments between 8 and 16 per cent. The average reduction was 12 per cent. The majority of the changes occurred within the first fifteen to thirty minutes. It was found that prolongation of the anesthesia two hours would not bring about further decrease in plasma volume unless the depth of anesthesia was also increased. After removal of ether, the plasma volume returned to normal or above within two to three hours.

Several interesting papers were reported bearing on the effects of sympathectomy. **N. E. Freeman** and **J. W. Zeller** reported on the effect of temperature on the volume of flow of blood through the sympathectomized paw of the dog, with observations on the oxygen content and capacity, CO_2 content, and pH of the arterial and venous blood. They used the plethysmograph method of determining volume flow on unanesthetized, trained dogs in which one adrenal was removed and the other denervated. They found that the circulation was in direct proportion to the height of the temperature of the bath in which the paw was immersed. The oxygen and CO_2 contents and the pH of the arterial and venous blood were constant within the limits of experimental error. They concluded that the circulation through regions deprived of vasomotor control seems to be determined by the metabolic requirements of the tissue.

The distribution of anhidrosis following interruption of various sympathetic pathways in man was studied by **Grace M. Roth.** The secretion of sweat under the

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influence of heat or pilocarpine was studied by applying cobaltous chloride to the skin and studying the development of color when the salt is wet. The tests were carried out on patients following sympathectomy of various types ranging from bilateral cervicothoracic and lumbar sympathectomy to the destruction of small portions of the sympathetic system. It was found that anhidrosis occurred in the skin areas corresponding closely to the segmental level at which the sympathetic nerves were distributed in the spinal nerves. The area of skin supplied by the gray rami of each ganglion corresponds roughly with that innervated by the corresponding dorsal root fibers. These studies are of importance to our knowledge of functional changes in specific areas following sympathectomy.

Another group of experiments which give some hope of eventual practical importance were reported by **C. H. Best** and collaborators on the effects of the injection of highly purified heparin, administered subcutaneously. Crude heparin has very little effect on the clotting time of the blood but by the use of a purified material, two doses of 1 c.c. each per day are sufficient to obtain nonclotting blood in animals weighing 15 kg. Taking their cue from protamine insulinate, these workers investigated combinations of heparin with other substances. They found that benzedine precipitates heparin from solution and the compound administered subcutaneously produces a more uniform and prolonged effect than an equivalent amount of the free material. They suggest that heparinization for prolonged periods may be of value in preventing certain types of thrombosis.

Important progress in another direction was reported by **Wallace D. Armstrong** who has made chemical studies of the differences between sound and carious teeth. He reported on the fluorine content of enamel and dentine. There is a surprising regularity in the findings of a decrease in fluorine in the unsound teeth. Without any overlapping of values between the normal and the carious groups, it was found that the carious teeth had on the average only 60 per cent as much fluorine as the normal. These findings give the first clear objective difference between sound and carious teeth. In view of the enormous importance of the problem of dental caries to human health, this study seems to be of great importance.

In connection with the problem of traumatic shock, **David Minard** studied the amount of histamine-like substances in the blood. An average increase in such substances of 80 per cent over the control was found in blood returning from the traumatized extremity of the dog. The author refrained from drawing any conclusions concerning the significance of the increase in the histamine-like substances in the causation of shock.

E. A. Boyden and **T. M. Berman** have contributed a significant study on the rate of emptying of the gallbladder in patients with gastric and duodenal ulcers. From a study of thirty-three ulcer patients, using methods which Boyden had previously employed extensively, they found that peptic ulcer markedly increased the rate of evacuation of the gallbladder. They consider that either the increased acidity or the increased motility of the stomach in peptic ulcer patients may be responsible for the faster evacuation of the gallbladder.

REPORT ON THE MEETINGS OF THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS, MEMPHIS, APRIL 21 to 24, 1937

RAYMOND N. BIETER, M.D., ST. PAUL, MINN.

(From the Department of Pharmacology, The University of Minnesota Medical School, Minneapolis)

ONE of the most interesting therapeutic introductions of recent years has been sulfanilamide and related compounds for the treatment of infections produced by virulent strains of hemolytic streptococci, meningococci, and certain strains of pneumococci. **Rosenthal** and **Bauer,** from the U. S. Public Health Service, have added further proof on the efficacy of certain of these compounds in experimental infections in mice. They reported further, upon another derivative, namely, what they call, di-sulfanilamide, which according to their data has a therapeutic ratio five times as great as sulfanilamide. It appears to be most active when given by subcutaneous injection; whereas, sulfanilamide and prontosil solution appear to be just as active orally as by injection. Their curative results in mice with sulfanilamide and prontosil solution show the same trend that is present in the literature, namely, that the former is somewhat more active than the latter against the hemolytic streptococcus. Against the pneumococcus Types I, II, and III, their new compound di-sulfanilamide appears to be the most active therapeutically.

Hanzlik, Lehman, and **Van Winkle,** from Stanford University School of Medicine, have submitted further data on the therapeutic activity of oral bismuth for the treatment of syphilis. Their preparation called "sobisminol" is a mass containing 3 per cent of $NaBiO_3$. It is not known at present, however, whether the bismuth exists as this salt when administered or whether the other ingredients produce a change. The bismuth is absorbed from the gastrointestinal tract and is present in the animal and human body in a manner similar to that following the intramuscular injection of water soluble bismuth preparations. Prophylactic and curative experiments in rabbit syphilis have been entirely satisfactory. Its use in human patients seems to indicate that a daily dose of 1.8 gm. is slightly too large for routine use because it is occasionally followed by stomatitis. A dose of 1.2 gm. per day, however, seems to be well tolerated. Its therapeutic action in patients seems to run parallel to that produced by intramuscular injections of bismuth. They have also devised a simple colorimetric test for following the absorption and excretion of the metal. If this test should be carried out on a large series of patients, it should yield some very interesting results. If the preliminary experiments are confirmed, oral bismuth is to be considered a step forward in the treatment of syphilis, for it should be much more satisfactory and less painful to the patient to use this form of administration rather than the method of injection.

Bleckwenn, Masten, and **Tatum,** from the University of Wisconsin, reported upon a clinical study of the picrotoxin—barbiturate antagonism. As is well known, Tatum and his associates have shown that picrotoxin antagonizes the depressant action and raises the minimal lethal doses of the barbital hypnotics in animals. This work has now been continued in man. Bleckwenn, who uses intravenous barbitals extensively in his psychiatric work, first of all brought out one exceedingly important point

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which all clinicians and surgeons would do well to follow, and that is, that these compounds when administered intravenously should never be given in concentrations greater than 5 per cent and then only at the rate of 1 c.c. per minute. They believe that the criterion of sufficient dosage is the just absence of the corneal reflex. At this stage, anesthesia to pain is not present. It is their belief that a deeper anesthesia than this from the barbitals is too dangerous for the vital functions of the body. Following this method of administration of various barbitals, they then proceeded to administer picrotoxin (1:1000 solution) at the rate of 1 c.c. per minute. It is given at this rate, and no faster, until the corneal reflex becomes positive, the miotic pupil dilates and consciousness returns. From then on consciousness remains, in contrast to what occurs following the use of the other commonly used antagonists which keep the patient awake for only a few minutes.

Some average figures, presented in a slide, from their patients illustrate the doses necessary to produce these effects.

DRUG	AVERAGE INTRAVENOUS DOSE OF BARBITAL HYPNOTIC. (AMOUNT NECESSARY TO PRODUCE ABOLITION OF CORNEAL REFLEX.) MG.	AVERAGE INTRAVENOUS DOSE OF PICROTOXIN (1 MG. PER MIN.). (AMOUNT NECESSARY TO PRODUCE RETURN OF CORNEAL REFLEX AND CONSCIOUSNESS.) MG.
Na thio nembutal	550	18
Na thio amytal	1100	25
Na nembutal	470	20
Na amytal	800	20

It is to be noted that 1 mg. of picrotoxin tends to antagonize from 30 to 40 mg. of a ''short acting'' barbital hypnotic. This antagonistic action has been used with satisfactory results in patients admitted to the hospital with acute poisoning due to the barbital hypnotics. They add, however, that they believe that his symptomatic treatment in itself is not always sufficient. Where the patient has taken the hypnotic orally they also use gastric lavage for several hours and follow it by the gastric administration of a saline cathartic, such as sodium sulfate, with the idea of this latter producing a decreased intestinal absorption of the hypnotic. The reviewer cautions physicians and surgeons against the use of this very worth-while therapeutic measure until they become thoroughly familiar with the technique and its pitfalls, either from Bleckwenn's complete publication (which is as yet unavailable) or from actual contact with the authors.

In this connection mention should be made of one of the papers read by title. **Cohen** and **Kohn,** of the Municipal Tuberculosis Sanitarium, Chicago, reported upon the satisfactory treatment of a woman, aged thirty-two years, who took, by mouth, approximately 1.1 gm. of amytal and 3.9 gm. of phenobarbital. During the first few days the picture of ''marked surgical anesthesia'' which she showed was uninfluenced by strychnine given to the point of producing slight convulsions. Thereafter, during the next few days, picrotoxin was given up to a total dose of 131 mg. During this therapy the patient awoke, and in another week she made an uneventful recovery. It was the belief of these authors that picrotoxin was superior to strychnine in combating this case of barbital hypnotic poisoning.

It is a well-known fact that it is quite difficult to produce diuresis in some surgical patients. It is also a sad fact that the underlying mechanisms involved in these patients is poorly understood. From this standpoint, the report of **Coon, Noojin,** and **Pfeifer,** from Professor Geiling's laboratory at the University of Chicago, is extremely interesting. These investigators, using unanesthetized bladder-

extrophy dogs, have found that solutions of NaCl, in concentrations of 0.7 to 0.9 per cent produced ''low'' curves of diuresis; whereas, concentrations of NaCl of from 0.1 to 0.6 per cent produced ''high'' curves of diuresis. These maximum diuretic effects were obtained with NaCl solutions that produced the least change in blood chlorides. It appears that a balance of both water and NaCl is necessary for optimum diuresis. Undoubtedly many clinical failures in diuresis are associated with these changes in balance. These findings, within limits, have been confirmed in man. In the normal human being maximum curves of diuresis were obtained with NaCl concentrations of from 0.1 to 0.25 per cent. The subsequent work of these investigators will undoubtedly do much to elucidate the optimum requirements and mechanisms involved in the rational use of fluids for diuresis, in hospital, and in particular, surgical patients.

Book Reviews

Clinical Roentgenology of the Cardiovascular System. By Hugo Roesler. Pp. 315, with 199 illustrations. Springfield, Ill., and Baltimore, Md., 1937, Charles C. Thomas, Publisher. $7.50.

There has been a long-felt need for an adequate monograph, in English, on the roentgen diagnosis of the diseases of the cardiovascular system. The combination of one of the foremost authorities in this special field with a splendid publisher gave promise of an unusual book. While the expectations aroused are not entirely fulfilled, nevertheless, this volume is fully adequate, highly accurate, in many portions shows unusual excellence, and is by far the best available treatment of this subject.

Two broad criticisms may be made. The first relates to the illustrations; the lack of a title for each and the awkward use of arrows make them somewhat difficult to use. Furthermore, the illustrations, of excellent quality, are insufficient in number. The second general fault lies in too great an economy of verbiage, particularly in relation to the common diseases. Those heart lesions which comprise the vast majority of the clinical cases, namely, essential hypertension and acquired valvular disease, are treated rather superficially. To the former there is assigned scarcely three pages and only one illustration. No effort is made to detail the changes in the heart during the various stages of hypertension, the value of the examination, or the differential diagnosis from other cardiac lesions. While acquired valvular disease is presented at greater length, the amount of space devoted to this subject is insufficient.

On the other hand, the knowledge imparted is generally accurate; the errors are essentially sins of omission. The sections on the technic of examination, the normal heart, diseases of the pulmonary arteries, congenital defects, and on diseases of the aorta are notably well done. The dynamics and gross anatomy of the heart are presented in great detail. Considerable attention is directed to kymography and fluoroscopy. The methods of measurement are discussed thoroughly and the conclusions derived are sound.

The bibliography is admirable, a splendid example for other American authors. The book is beautifully printed, although the type face appears rather small. Altogether this is a volume which is indispensable to roentgenologists and cardiologists and very valuable to any physician who concerns himself with cardiac diagnosis.

Diagnostic Roentgenology. By Ross Golden. Fabrikoid. Price $20. Pp. 854, with 964 illustrations. New York, 1936, Thomas Nelson & Sons.

This admirable volume under the editorship of Ross Golden is a much-needed and timely publication which will serve a very useful purpose among clinicians and roentgenologists. It is easily the best publication in English on roentgen diagnosis and deserves to be widely read and studied. Fifteen American authors, all well known in their special fields of interest, have collaborated to make the eleven chapters of the book an authoritative monograph on diagnostic roentgenology. The quality of the mechanical production is excellent. The illustrations, in the main, are good, and well-chosen bibliographies accompany each chapter.

Particularly deserving of commendation is the chapter on "The Roentgen-Ray Diagnosis of Diseases of Bones," written by Hodges, Phemister, and Brunschwig. The roentgen and clinical aspects of osseous diseases have been unusually well integrated. The striking superiority of this conjoint mode of treatment of subject matter by radiologist and clinician would suggest it as the rational prototype in a work of this kind. Encyclopedic systems of medicine and surgery are available by the score. It would appear that there is great need and that there would be ample demand for such a system of diagnostic roentgenology. For, whereas this splendid volume of 854 pages treats adequately of many of the major categories of disease, serious omissions, at the same time, are prominent. There is no mention of dislocations. The matter of localization of foreign bodies in tissue and the use of fluoroscopic aid in their removal receives no consideration. The reviewer had fully expected to see some discussion of the roentgen diagnosis of branchial cysts; of the value of roentgen diagnosis in tracing out sinuses and fistulas; of the importance of the roentgen rays in detecting compression of the trachea, and something of the roentgenography of the reticuloendothelial system. The great worth of roentgen evidence in the recognition of acute abdominal disorders is not accorded the consideration which the value of such examinations contributes to correct diagnosis. The roentgenologist has invaded almost every activity of diagnostic medicine. Probably only a system of roentgenologic diagnosis well coordinated with the clinical approach could adequately discuss all these problems.

The case histories accompanying the illustrations, employed by Ross Golden, the editor, in the section on the "Roentgen-Ray Examination of the Digestive Tract," enhance greatly both illustrations and text and are extremely helpful to the reader. Every writer of medical books would do well to emulate this effectual use of complete illustrative case records.

This monograph of diagnostic roentgenology, replete with authoritative and useful information on many and diverse corporal ills, can be enthusiastically recommended to every practitioner of medicine and surgery. It should also receive a cordial welcome by radiologists and medical and surgical specialists.

Modern Motherhood. By Claude Edwin Heaton. With an introduction by Hazel Corbin. Cloth. Price, $2. Pp. 271, with one illustration. New York, 1937, Farrar & Rinehart, Inc.

This book contains twenty-three chapters of information for anyone interested in the question of childbirth, as well as detailed instructions for parents. It is written in such an easy, readable style that this reviewer was loath to put it down without finishing it. The usual prenatal advice is critically reviewed and brought up to date. As an example in regard to clothing, it is stated: "Little need be said about clothing. To read most of the absurd advice given, one would think doctors knew very little about what a pregnant woman should wear." The text is arranged in four parts: pregnancy, childbirth, human reproduction, and obtaining adequate medical care. The chapter on diet in pregnancy is full of common-sense advice with minimal emphasis on the fundamentals of nutrition, a subject which very few lay readers probably understand. The question of maternal morbidity and mortality is well reviewed. One might question the wisdom of giving too detailed advice on the care and feeding of the newborn. The expectant father comes in for considerable attention. Obstetric economics and a good section on obstetric history are excellent features. There is a bibliography and glossary at the end. This book can be read with profit by anyone interested in the question of modern motherhood, including physicians.

Preoperative and Postoperative Treatment. By Robert L. Mason. Cloth. Pp. 495, with 123 illustrations. Philadelphia, 1937, W. B. Saunders Company. $6.

This monograph written by Dr. Robert L. Mason, with the help in special parts of eleven collaborators, deserves to be widely read. It is a book which should appeal alike to students of medicine, surgical house officers, and practitioners, as well as to specialists in surgery. The material is well organized and the subject matter includes the newest and most authoritative expressions extant.

So often books on preoperative and postoperative treatment are but a series of the author's favorite recipes for the management of certain situations. Such is not the case in this manual. The approach to problems by the authors has been rational and physiologic. At the same time they have taken pains to describe devices and maneuvers which have proved useful in their own experience. The illustrations are good but could well have been more generously employed for purposes of elucidating the text. It is unfortunate that the only technical procedure illustrated, viz., the performance of enterostomy for the relief of a distended bowel, should have been so poorly chosen. The reviewer shares with others the impression that the distended bowel in obstruction cannot be most safely and aseptically drained in the manner illustrated (so-called Hendon's enterostomy). A complete index of subject matter enhances the utility of this valuable monograph on preoperative and postoperative treatment. An astounding amount of valuable and informative material has been crowded between the two covers of this book.

Anleitung zur Schmerzbetäubung. By Dr. Fritz F. Härtel unter mitwirkung von Dr. Horst Jencio. (Vol. 21 of a series for medical education for the man in general practice.) Pp. 106, with 17 illustrations. Dresden, 1936, Theodor Steinkopff. Pamphlet price, 10 M.; bound, 11.50 M.

The author has done well in his brief work on anesthesia for office and emergency work. The booklet is especially suitable for a young surgeon.

The discussions on *Rausch*, on therapeutic and diagnostic block, and on complications during general anesthesia are detailed and accurate. Light anesthesia or *Rausch* is recommended for minor surgery, as for setting simple fractures. Ethyl chloride is advised, though vinyl ether and solästhin (CH_2Cl_2) are mentioned.

Illustrations clearly show techniques for use in a number of therapeutic and diagnostic blocks. Trigeminal, sciatic, brachial, facial, and sympathetic nerve blocks in general are discussed. The author considers that procaine is still the usual agent of choice for block or infiltration anesthesia. Alcohol injections for permanent blocks are discussed in some detail.

Respiratory and circulatory complications during general anesthesia are considered in detail. The author stresses keeping an open airway. If holding the jaw does not keep the tongue forward, an artificial airway should be used, such as the Mayo tube. Overdose of an anesthetic agent should be treated by artificial respiration, either manually or by tongue traction. Pulse readings at the wrist are better than at the neck for judging the state of the peripheral circulation. The usual cardiac stimulants are mentioned, but not the use of fluids for shock. Blood pressure readings are not mentioned.

Ether is recommended for long anesthesias. Chloroform may be better in special instances, but the author states that its administration today is almost a lost art.

Too little discussion is given on preoperative medication, on accidents during block anesthesia, on gaseous agents, and on special techniques with inhalation agents.

The author feels that maintaining good understanding with the patient is essential in block anesthesia, since psychic contact may avoid undesirable reactions, such as fainting. No mention is made of using barbiturates as prophylaxis against cocaine or procaine reactions.

Nitrous oxide and acetylene are discussed, but no mention is made of ethylene or cyclopropane, though a full and up-to-date evaluation of intravenous barbiturates and vinyl ether is given. Endotracheal techniques are not mentioned.

Avertin is discussed for basal narcosis and for the treatment of tetanus. Spinal anesthesia is the method of choice for abdominal surgery.

The booklet is well written, although it has limitations in being written by a surgeon for surgeons. There is little new in it for the American surgeon or anesthetist who has access to standard works on block anesthesia and to current literature.

Christian R. Holmes: Man and Physician. By Martin Fischer. Cloth. Price, $4. Pp. 233. Springfield, Ill., 1937, Charles C. Thomas, Publisher.

This book relates the interesting story of the development of the Cincinnati General Hospital and its establishment as an important unit in the Medical School of the University of Cincinnati. The scheme for the accomplishment of these objectives had its origin in the practical imagination of the Danish immigrant boy, Christian R. Holmes, who envisaged the plan, formulated largely the technical particulars of the building and construction, persuaded the people of Cincinnati of the necessity and value of such a project, secured additional endowments for its smoother operation, and finally coordinated the structure and staff of this great municipal hospital with the teaching program of the University of Cincinnati.

Dr. Fischer has related, in such a fascinating manner, the story of how the prodigious worker, Holmes, accomplished these ends, that this book should receive a ready welcome by medical men. The quality of the production of the book is excellent.

Diabetes: A Modern Manual. By Anthony M. Sindoni. Cloth. Pp. 240. New York, 1937, Whittlesey House, McGraw-Hill Book Company. $2.

This book is the third in a series of popular presentations of medical subjects. It is divided into three parts devoted to questions asked the physician, what to know and what to do.

The book is well written and should be fairly well understood by intelligent diabetic patients. There are many practical suggestions made for diabetic procedures, and the reasons for these are usually well stated.

The inclusion of the subject of protamine zinc insulin is of timely interest and is discussed conservatively.

The physician, as well as the patient, will find this book of some value. Some would undoubtedly take issue with certain contentions made, such as the advice that insulin invariably be given after meals. On the whole, the book compares favorably with other diabetic manuals.

Books Received

The receipt of books is acknowledged in this section and this statement must be regarded as sufficient acknowledgment of the courtesy of the sender. Selections will be made for more extensive review dictated by the interests of our readers and as space permits.

SURGICAL TREATMENT: three volumes with separate index. By James Peter Warbasse, Special Lecturer in Long Island Medical College, and Calvin Mason Smyth, Jr., Assistant Professor of Surgery in University of Pennsylvania Graduate School of Medicine. Cloth. Price $35. Volume I, 906 pp.; Volume II, 782 pp.; Volume III, 798 pp. Index, 131 pp. 2,486 illustrations on 2,237 figures, some in colors. Philadelphia, 1937, W. B. Saunders Company.

DISEASES OF THE NOSE AND THROAT. By Thomson. Cloth. Price $14. Ed. 4. Pp. 976, with 386 illustrations. New York, 1937, D. Appleton-Century Company, Inc.

TRAITEMENT CHIRURGICAL DU CANCER DU COLON PELVIEN. By Pierre Bertrand, Ancien Chef de Clinique Chirurgicale á la Faculté de Médecine de Lyon, and E. Corajod, Chef de Clinique Chirurgicale á la Faculté de Médecine de Lyon, with preface du Professeur Tixier. Paper. Price 30 fr. Pp. 207, with 35 illustrations. Paris (VI^e), 1936, Masson et Cie.

ELEMENTS OF ORTHOPAEDIC SURGERY. By N. Ross Smith, Orthopaedic Surgeon, Cornelia Hospital, Poole, Australia, with foreword by R. C. Elmslie, Orthopaedic Surgeon, St. Bartholomew's Hospital. Cloth. Price $4. Baltimore, 1937, William Wood & Company.

A BRIEF OUTLINE OF MODERN TREATMENT OF FRACTURES. By H. Waldo Spiers, Professor of Orthopaedic and Fracture Surgery, College of Medical Evangelists, Los Angeles, California. Cloth. Price $2. Ed. 2. Baltimore, 1937, William Wood & Company.

MATERNAL CARE: THE PRINCIPLES OF ANTEPARTUM, INTRAPARTUM, AND POSTPARTUM CARE FOR THE PRACTITIONER OF OBSTETRICS. By Dr. F. L. Adair, Editor, University of Chicago. Paper. Price $1. Pp. 93. Chicago, 1937, University of Chicago Press.

A MANUAL OF OPERATING ROOM PROCEDURES. By Almira W. Hoppe, Science Instructor, Jewish Hospital, St. Louis, and Lucile M. Halverson, Supervisor of Operating Rooms, University of Minnesota. Paper. Price $2. Pp. 239. Minneapolis, 1937, University of Minnesota Press.

LEGAL MEDICINE AND TOXICOLOGY. By Thomas A. Gonzales, Acting Chief Medical Examiner of the City of New York; Morgan Vance, Assistant Medical Examiner of the City of New York; and Milton Helpern, Assistant Medical Examiner of the City of New York; with a foreword by Harrison S. Martland, Chief Medical Examiner, Essex County, New Jersey. Cloth. Price $10. Pp. 754, with 244 illustrations, some in color. New York, 1937, D. Appleton-Century Company, Inc.